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R.A.F. ELECTRICAL ENGINEERING

THE aircraft shown in the cover illustration this month, the Vulcan Mk. II, is probably the most versatile of the R.A.F. V-bombers and is now replacing the Mk. I version which has been in service for a number of years. It is the first R.A.F. bomber to be equipped with the new a.c. electrical system working to a standard of 200 volts, 3-phase, 400c/s, with an installed capacity of 200kVA.

The Foreword on p. 691 is devoted to a review of electrical engineering in the Royal Air Force

Secretary W. K. BRASHER, C.B.E., M.A., M.I.E.E. *Editor* W. G. ASKEW, M.C.

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JOURNAL

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ELECTRICAL ENGINEERING IN THE R.A.F.

BEFORE the Second World War, military-aircraft engineering was, although it may not have appeared so at the time, a comparatively simple matter. Although there were many problems, they stemmed more from unfamiliarity with a new art than from the intrinsic complication of the aircraft. Practically all the techniques employed were mechanical, and electricity played a very small part in aircraft operation.

The tremendous developments in military-aircraft performance that have occurred in the last 30 years are well known. Not so well known, but of equal significance, are the radical changes that have been taking place in the internal design of Royal Air Force aircraft.

Before the 1939–45 War, an aircraft consisted of an assembly of mechanical devices, simple in construction though not perhaps in application, that required little or no electrical power. Over the years, almost imperceptibly, there has been a gradual but persistent swing from the mechanical to the electrical. All the same, this infiltration of electricity into a predominantly mechanical field was for many years confined to what might be called the ancillary devices rather than the fundamental components concerned with flying the aircraft. It is only very recently that electrical devices have replaced or supplemented mechanical systems for direction of the aircraft itself.

Radio equipment was the first to need electrical power in any quantity, but in the early days these demands were easily met. As communication sets developed and were supplemented by radar equipments to provide navigation, bombing, search and interception facilities, so power demands increased. At the same time, the electrical services of the aircraft developed with the increasing use of indicating, lighting, control and measuring equipment.

Even so, the power required could easily be produced by fairly small engine-driven generators. Standard aircraft practice at this time was to generate direct current at low voltage, converting to alternating current for radio and other uses. Starting at 12 volts, the basic supply voltage has increased through 28 eventually to 112 volts for the more complicated aircraft.

More recently, with the introduction of the V-bombers and supersonic fighters, electricity has graduated from its ancillary role and now plays a full part in all aspects of aircraft operation.

Flight-control computers are now fitted, which are capable of flying the aircraft to a predetermined programme that can be varied by the pilot or ground controller through an air-data link. Automatic landing systems can bring an aircraft down to the runway in any weather. Automatic weapons-systems can fire guns or guided weapons, following radar-tracking information and course computation. Instruments previously entirely mechanical are now universally electrical, displaying transmitted information from central gyro-stabilized platforms or data computers. Fuel consumption is measured, and range and flight endurance are automatically computed.

With all these developments, each demanding electrical power, d.c. systems have reached their limit, and combat-aircraft electrical systems are now required to work to a standard of 200 volts, 3-phase, 400c/s, with an installed capacity of 200kVA and an emergency standby of 50kVA.

The problems of maintaining in a constant state of readiness this ever-increasing mass of complex equipment are readily obvious. There are, however, many ways in which industry can help. The requirements for minimum size and weight are too well appreciated to be restated. Equally well known is the inevitable tendency to expect equipment to operate at twice its designed performance and to be compressed into half its prescribed space. Perhaps the most important requirement for the future, however, will be that of utmost reliability. This is not new, but standards will be much higher, and the ability to run for long periods without any sort of failure is likely to be demanded of all equipment.

At the same time, reliability of another sort will be needed in certain instances, particularly in weapons systems. This is the ability of components to remain dormant for long periods with little or no maintenance, and yet to respond with absolute certainty as soon as

required. This need to produce components to exacting design standards, yet with utmost reliability, poses a stimulating challenge to the manufacturing industry.

These are the problems facing the electrical engineer in the Royal Air Force today. If they are to be solved, the first need is to recruit and train the engineers needed by the Service. At the end of the Second World War, it was decided that all General List Technical Officers (representing one-third of the total of Technical Officers) must be trained to nationally-recognized engineering standards. All subsequent experience has confirmed the wisdom of this decision.

The main source of recruitment of General List Technical Officers is through the Technical Cadet scheme. Cadetships are of two kinds, referred to for convenience as 'Henlow' or 'University' cadetships. All cadets spend their first year at the R.A.F. Technical College. University cadets are then sent to a university to study for an honours degree in mechanical, electrical or aeronautical engineering. Henlow cadets continue their training at the R.A.F. Technical College for a further two years. Completion of this course to a prescribed standard carries with it complete exemption from the whole of the Institution Examination.

In addition to the cadets, professionally qualified engineers may be commissioned directly from civilian life. In order to compensate such entrants for their long training and subsequent experience, a scheme has recently been introduced whereby direct-entry officers who are Chartered Engineers may have their seniority ante-dated by up to nine years. This enables them to be entered part-way up the promotion ladder and puts them in a position comparable with those of their own age who may have entered somewhat earlier.

Looking ahead to the more distant future and to the introduction of space vehicles, the problems may be more severe but undoubtedly they will be of the same kind. Space and weight will be even more at a premium, and components will need to be so reliable that they not only operate at the first time of asking, but continue to do so without maintenance for long periods. This is the challenge to the industrial designer—it is a severe one, but no doubt it will be answered with the same efficiency and dispatch with which all previous Service requirements have been met.

World-wide submarine telephone-cable projects

In spite of the possibilities of transmitting messages via satellites in space, submarine cables, both telegraph and telephone, will continue to play a big part in world communication.

1961 will see the start of an ambitious project by the Commonwealth Governments to lay a network of submarine telephone cables of large capacity that will encircle the world. The cost will be about £88 million. The Anglo-Canadian transatlantic telephone cable will be the first part of the project. In 1962 a start will be made on laying a trans-pacific telephone cable between Canada and Australasia. This cable, which it is hoped to finish laying in 1964, will link Australia and New Zealand with Canada, and thence, via a microwave system across Canada and the transatlantic cable, with the United Kingdom.

The transpacific cable will be one of the largest telecommunication projects ever undertaken. It will be 8000 nautical miles long, with more than 300 undersea repeaters, and will have a capacity for at least 80 simultaneous telephone conversations. In places, the cable and repeaters will be laid at depths of almost four miles.

New cable ship

The use of the new light-weight cable and repeaters, designed and developed by the British Post Office and British manufacturers, has revolutionized submarine telephone equipment in recent years. This has made great demands on cable-ship equipment. H.M. Telegraph Ship *Alert*, launched on the 7th November 1960 at Govan, Glasgow, has equipment specially designed to meet these demands.

Alert has been designed as a dual-purpose submarine cable-laying and repair ship. Her primary function will be to maintain the expanding network of long-distance telephone cables in the North Atlantic. She has been specially equipped for this rigorous service and will supplement the work of H.M. Telegraph Ship *Monarch*, 8065 tons gross, at present the largest cable ship in the world.

When commissioned in February 1961, *Alert* will be engaged on laying the St. Lawrence section of the Anglo-Canadian transatlantic telephone cable between Corner Brook (Newfoundland) and Grosses Roches (Quebec), Manahawkin (New Jersey), and Bermuda.

Expansion of telecommunication

An idea of the expansion of Commonwealth telecommunication facilities is given by the increase of telephone and telex traffic. The total originated international telephone traffic over the Commonwealth system showed an increase of over 11% in 1959 as compared with 1958, and the international telex traffic an increase of over 18%.

These increases have led to a growing number of cable projects. In view of this, Cable and Wireless Ltd. are having two extra cable ships built—one for cable repairs, the other for cable laying. The cable-laying ship will be nearly as large as the *Monarch*.

The Americans also have long-term plans for laying cables in the Pacific, and the American Telephone and Telegraph Co. have placed an order for a 16000-ton cable-laying ship with a West German shipyard in Hamburg.

An electrical engineering review

621.315.23 MAINS CABLES

This article is confined to mains cables for voltages up to 11 kV and, until recently, this meant that practically the only type concerned was the paper-insulated and metal-sheathed type. The present-day picture is different because of the introduction of plastics-insulated mains cables. The author is with British Insulated Callender's Cables Ltd.

P. W. CAVE, B.SC., MEMBER

ALTHOUGH development has continued steadily in all branches of paper-insulated-cable design and manufacture since the first British Standard (7) was published in August 1904, there have been two periods in which development has been particularly rapid and varied. Very approximately, these periods were the years between 1927 and 1932 and between 1954 and 1960.

The first of these periods saw the introduction of pre-spiralled conductors, screened insulation for the higher-voltage cables, and improved beddings and servings for all buried cables. The past six years have seen the introduction, on a commercial scale, of mass-impregnated non-draining cables, corrugated-aluminium-sheathed cables, water-cooled cables and plastics-insulated cables, and these are the items which are covered by this article.

Conventional cable construction

To understand better the developments which have taken place, it is necessary to explain briefly the assembly of a conventional mains cable as covered by the current British Standard, 480 : 1954.

The conductors in this standard have remained substantially unchanged since pre-spiralling was introduced in the late 1920's. They are built up from seven sizes of annealed high-conductivity copper wire, with geometric strandings of 7, 19, 37, 51, 91 and 127 wires for all circular conductors. For shaped conductors, the same numbers of wires are used, but a tolerance of ± 1 wire is permitted on all except 7-wire conductors.

A development which is continuing rapidly in conductor manufacture is towards the production of compact conductors, both circular and shaped. A considerable saving in insulating and protective materials will result from these compact conductors, and specifications of the future will have to be written so as to permit their use. Eventually, this will mean the end of the conventional strandings which have been in use for the past half-century.

A compact conductor is defined as one having a space factor, i.e. the proportion of actual metal in the space occupied by the conductor, exceeding 90% compared with 75–77% for normal stranded circular conductors. The operation of compacting may be performed by drawing the strand through a stationary die. The resulting work-hardening of the copper, apart from reducing flexibility, increases the resistance, so that a subsequent annealing process may be necessary. This work-hardening, however, can be minimized by using pre-shaped wires to build up the strand. It is on these lines that development work is proceeding fairly rapidly.

Impregnated-paper insulation

In conventional cables, impregnated-paper insulation is built up to the specified thickness by lapping-on paper tapes having thicknesses ranging from about 4 to 7 mils. In the mass-impregnated construction, the paper is lapped-on in its natural state and is then thoroughly dried by the combined application of heat and vacuum. It is then impregnated with insulating compound.

The process is carried out in a hermetically sealed steam-heated vessel, with the cable heated to 120°–130° C before vacuum is applied. While still under vacuum, compound heated in a separate vessel to approximately the same temperature is admitted to the cable and completely fills all the pores in the paper and all the interstices in the cable assembly. After impregnation, the cable is allowed to cool down under compound so as to minimize void formation due to compound shrinkage. Then the metal sheath is applied.

The elimination of voids is of little importance with low-voltage cables but is very necessary with cables for 11 kV upwards.

In another type, the pre-impregnated type, the papers are dried and impregnated before application to the conductor, and there is, therefore, no subsequent drying and impregnation process.

For mass-impregnated cables, it is usual to employ a compound which is a mixture of oil and resin. The electrical properties of the resulting insulation are adequate, but, owing to its semi-fluid nature, the compound tends to migrate from the higher to the lower levels when the cable is laid on a gradient. The rate of migration increases with increase of temperature due to load.

The effect of this migration is to reduce the compound content and increase the tendency to void formation at the higher levels, and to cause compound to leak from the termination at the lower end. While the former is not harmful at the lower voltages, say up to 3·3 kV, the leakage of compound can be objectionable. At higher voltages, drainage of compound from the insulation

can seriously impair the electric strength of the insulation. In extreme cases, electrical failures have resulted, owing either to void formation at the higher levels or to bursting of the sheath at the lower levels by excessive internal pressure owing to the head of compound.

1 *Corrugated-aluminium sheath—seamless type*

It used to be common practice, when it was known that a cable would be installed on a gradient, deliberately to drain the cable at the factory, after impregnation but before sheathing, by allowing it to stand in a hot oven. The weakening of the insulation, electrically, owing to this draining process, was compensated for by increasing the thickness of insulation, so that drained-type cables for 6 and 11 kV had thicker insulation than the standard used for normal fully impregnated cables.

The pre-impregnated cable does not suffer from this kind of trouble because the paper is dried and impregnated in sheet form before application to the cable; there is, therefore, only one thickness of paper to dry and impregnate, and a compound having a much higher viscosity can be used. For this reason, pre-impregnated cables are inherently non-draining.

The drainage trouble with the mass-impregnated construction has now been overcome by the introduction of compounds which have a very high viscosity at normal operating temperature and, therefore, do not drain. The resulting cables are described as either mass-impregnated, non-draining, or fully impregnated, non-draining, depending on who makes them.

With one manufacturer, the non-draining characteristics are obtained from a dispersion of polythene in selected grades of petroleum jelly, but other manufacturers use compounds containing microcrystalline waxes. With all these types of non-draining cable, the same thicknesses of insulation are used as for normal mass-impregnated cables, and they are available for all voltages up to and including 33 kV.

Sheathing materials

Before the 1939–45 War, the only sheathing materials used for mains cables were lead or lead alloy, but, in more recent years, aluminium has become established as an alternative sheathing metal. Whereas the lead or lead alloy was applied by direct extrusion to the impregnated-paper-insulated cable, there has been little progress so far in this country with the direct extrusion of aluminium.

Alternative methods of producing an aluminium sheath have been by drawing the cable into an oversize sheath and then drawing the sheath down through a reducing die until it is a reasonably tight fit over the cable, or by fabricating the sheath from aluminium strip folded round the insulation, and seam-welding by the argon-arc process.

One advantage of the latter method is that there is practically no limitation on length, but both types suffer from the disadvantage that the resulting cable is a good deal stiffer than the corresponding lead-sheathed cable, and this leads to difficulties in erection, especially in confined and tortuous runs. Some means of improving their flexibility was obviously required, and this has been achieved by the use of corrugated-aluminium sheath.

This type of sheath can be bent to the same radius and with the same ease as a lead-sheathed cable. The corrugations can be formed with equal facility in swaged-down, seamless aluminium-sheathed cables or in cables manufactured by the argon-arc process, but the contours of the corrugations are different in the two types. In the former (Fig. 1), the corrugations are semi-cylindrical with flat sheath between them, whereas in the latter they are approximately sinusoidal.

Protective coverings

Protective coverings protect the sheath or armour from corrosion. They also serve as a cushion to prevent damage to the lead sheath when the armour is applied. Until recently, jute has always been used for mains cables, either in the form of roving, or woven into hessian tape. In the early days, the jute and hessian tapes were impregnated with coal tar, and further tar and pitch compounds were applied at the serving or armouring machine. The usual construction consisted of one or two layers of jute, or two layers of hessian under and over the armour.

The only modification to this was introduced in the late 1920's as a result of numerous cases of sheath corrosion, which were thought by some to be due to phenols in the coal tar but were later proved to be due to decomposition of the jute, producing acetic acid which attacked the lead sheath. The very effective remedy of interposing two layers of compounded paper between the jute and the lead sheath was introduced, and at the same time the use of coal tar as an impregnant and as a serving compound was largely abandoned in favour of petroleum residues.

Compounded cotton tapes were also included as a standard serving material, and we still have today, for all lead-sheathed cables laid in conditions where the corrosion hazard is negligible, the standard bedding of armoured cables (or serving of unarmoured cables) comprising two compounded papers followed by a layer of compounded jute or by two compounded hessian tapes, or one compounded cotton and one compounded

hessian. The incidence of trouble in normal conditions of installation is rare, as are the cases where corrosive soils are encountered which call for a more elaborate form of protection.

The introduction of aluminium sheaths, however, changed the picture, because it was found that conditions which had proved harmless to lead with standard beddings and servings produced severe corrosion of aluminium when protected with similar servings. Concurrently, the need to protect the reinforcing tapes of gas- and oil-filled cables from corrosion in all conditions of laying resulted in the development of anti-corrosive servings containing rubber or p.v.c. or a combination of the two.

Anti-corrosive servings

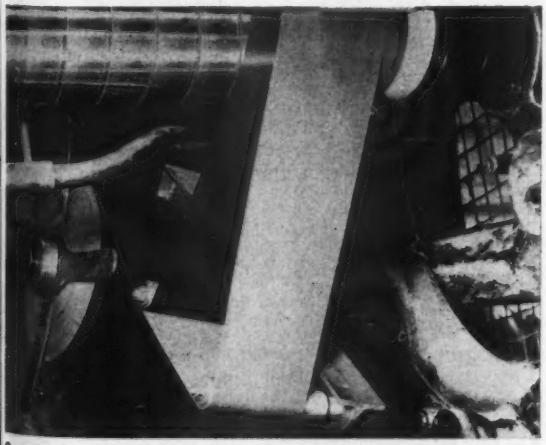
Although, strictly speaking, it is outside the scope of this article, it is not inappropriate to mention at this juncture the developments in protective coverings which were concurrently taking place in the field of gas- and oil-filled cables.

In the early days, the metal-tape reinforcement of the pressure-retaining lead-alloy sheath was protected from corrosion by a second lead sheath applied over the reinforcement, and this in turn was protected by compounded fibrous coverings as used for solid-type cables.

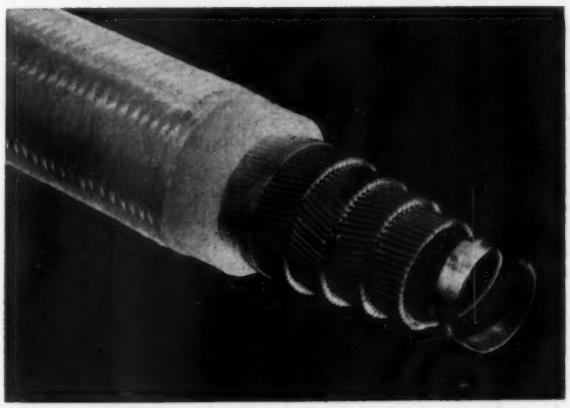
The shortage of lead during the Second World War led to the abandonment of this second lead sheath and the substitution of a fully anti-corrosive covering. Intensive development work ensued to find the ideal covering, and the saline-bath test, first introduced over 25 years ago as a means of assessing the corrosion-resisting properties of all types of serving, was brought into constant use.

Broadly speaking, the test consists of immersing 5yd samples of cable in a 0·5% solution of common salt, heated daily to 75°C and then allowed to cool down. A voltage of 10 volts d.c. is applied continuously across the protective layer between metal sheath, reinforcement or armour and the solution, and the leakage current is measured. The sample is subjected to daily heat cycles, 8 hours' heating to 75°C and 16 hours' cooling to ambient temperature, and it is required that after 100 such heat cycles the leakage current shall not have increased by more than 10μA.

In recent years the test has been made more stringent by having the sample, before immersion, subjected successively to a bending test, an abrasion test and a penetration test designed to simulate conditions during and after installation.



2 *Application of composite p.v.c.–rubber corrosion-resistant protection*



3 *Water-cooled cable*

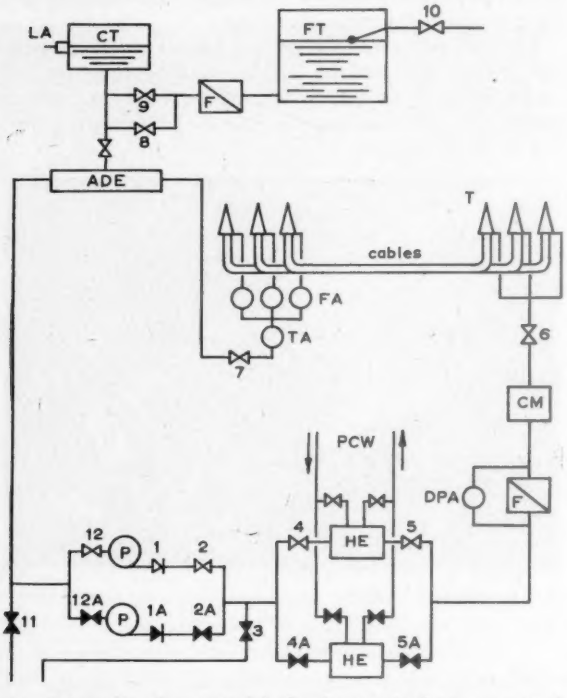
There emerged from all this work a number of coverings, differing in detail, but all containing rubber or p.v.c., or a combination of the two, as the water-impermeable membrane which gives the covering its corrosion-resistance. The desire for standardization has reduced the number to two, namely a lapped covering consisting of layers of p.v.c., rubber and hessian tapes, or an extruded sheath of p.v.c. Fig. 2 shows the composite p.v.c.–rubber type of protection being applied to the reinforcement of an oil-filled cable.

P.V.C. sheathing as a serving for all classes of mains cable is increasing. The oil companies and the National Coal Board have practically adopted it as a standard, and it is the preferred form of protection for corrugated-aluminium-sheathed cables. In addition to providing good protection against corrosion, it is flame-resisting and is not affected by most oils.

The increasing use of p.v.c. for buried cables is leading to an identification difficulty. Water Boards are turning to polythene as a material for water pipes. Both p.v.c. and polythene are being used as sheathing materials for buried Post Office cables and as a protective sheath for gas pipes. For technical reasons, black is the favoured colour, which makes it impossible to readily differentiate between an electric cable, a gas pipe, a water pipe and a telephone cable. It does not require much imagination to see that this could lead to serious consequences.

Fortunately, a solution to the difficulty has been found,

and it is possible that in the near future it will become standard practice. Suitable lettering can be embossed on the surface of the sheath, and the words 'ELECTRIC CABLE' repeated at frequent intervals should solve the identification problem for mains cables, which are the most lethal if cut into by mistake.



4 *Schematic of a typical hydraulic circuit for a generator/generator transformer interconnector*

P	pump	FA	flow alarm
HE	heat exchanger	ADE	air-detraining enlargement
F	filter	LA	level alarm
DPA	differential-pressure alarm	CT	control tank
CM	conductivity monitor	FT	feed tank
TA	temperature alarm	PCW	primary cooling-water supply
1–12	control valves: white—normally open; black—normally closed	T	cable terminations

Water-cooled cables

This is a new development, and it is not easy to forecast its future use. The necessity for water-cooling arises from the increasing loads which have to be transmitted and the desire to keep down the number and size of cables by operating the conductors at much higher current densities than are possible with the conventional construction.

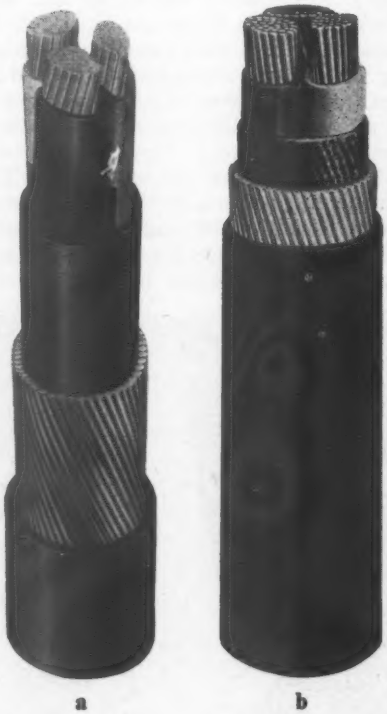
For maximum efficiency, the water is pumped down the centre of the cable, and Fig. 3 shows one particular form of water-cooled cable. This is a 0·5in.² 11kV polythene-insulated cable, and the conductor is built up round a ¾in. copper duct. Fig. 4 shows the lay-out of the hydraulic connections used in conjunction with a main generator circuit. It is, of course, essential that deionized water be used for circulation through the cable, and a conductivity monitor is included in the hydraulic circuit. An air-detraining enlargement removes any dissolved air from the water.

Installations of this nature have their limitations because the maximum temperature at which the cable can operate is governed by the conditions at the water outlet, which, in turn, depend on the maximum rate of flow and the length of cable concerned.

In an economic appraisal of a system employing water-cooled cables, it is necessary to take into consideration not only the cost of the cable installation itself, but also the capitalized cost of the conductor losses, which are much higher than in an installation employing conventional cables.

Armoured plastics-insulated mains cables

The shortage of rubber during the war years led to the introduction of p.v.c. and polythene as insulants for wiring cables, and these materials were also used to a limited extent for house-service cables. In more recent years, the use of plastics in the cable-making industry has made rapid strides, and plastics insulation is tending to displace paper insulation. The relative ease of termination, coupled with the very distinctive colours which are



5 *Two p.v.c.-insulated cables*

a p.v.c.-sheathed—suitable for laying directly in the ground
b suitable for erection, indoors, in air

readily producible for core identification, make p.v.c. an ideal insulant for pilot and telephone cables.

Then, as already noted in the discussion of protective coverings, p.v.c. is being increasingly used as a corrosion-resistant sheathing for buried cables wherever the conventional textile coverings are inadequate. It is, therefore, not surprising that the successful use of p.v.c. in these fields has led to the idea of using it for mains cables, whether buried directly in the ground or installed in air.

A British Standard has been drawn up and should shortly be published, setting down standard constructions for p.v.c.-insulated and armoured cables for voltages up to and including 3·3kV. It covers a complete range of conductor sizes from 0·002 to 1 in.^{2} None of the cables has a metal sheath, but all are armoured with a single layer of galvanized-mild-steel wires. For the bedding

6 *11kV self-supporting polythene-insulated aerial cable*

under the armour and for the serving over the armour, there is a choice between fibrous materials and p.v.c. sheaths.

Where the cable is to be buried directly in the ground, the p.v.c.-sheathed variety (Fig. 5a) having non-hygroscopic fillers should be used to obviate the risk of moisture being conducted along the cable to joints and terminations. Fibrous beddings or fillers would act as a wick, and the resulting accumulation of moisture inside the joint or termination could lead eventually to electrical breakdown.

On the other hand, where a cable is to be erected in air in a reasonably dry situation, moisture migration along the cable is not a hazard, and, in such cases, the cheaper construction having fibrous fillers and bedding will prove quite satisfactory (Fig. 5b).

Summary

It is reasonably certain that the use of plastics-insulated cables of one type or another will extend, as will the range of voltage at which they can be used. The replacement of the armour by a layer of copper or aluminium wire or strip and the use of this concentric conductor as the neutral is a development which may well find favour, especially in distribution systems which employ protective multiple earthing. At present, 3·3kV is the highest voltage for which plastics-insulated cables have been standardized, but cables up to 33kV, insulated with polythene, are in commercial use.

One installation which points the way to the future is the 11kV self-supporting polythene-insulated aerial cable (Fig. 6). This cable enabled an 11kV supply to be carried through woodland in one of our National Parks without any of the timber-felling which would have had to be done if bare overhead conductors had been used.

There will doubtless be many similar interesting applications of plastics-insulated cables in the future, and they may displace paper-insulated cables to a greater and greater extent as time goes on.

The remaining developments mentioned in this article all have their own field of application. Non-draining insulation, of whatever type, may well become the standard for all cables up to 11kV or even 33kV, and corrugated-aluminium sheaths will almost certainly displace cylindrical aluminium sheaths, on account of their handling properties. The extent to which water-cooled cables will be used is much more problematical.

Her Majesty the Queen at the opening of Kincardine generating station on the 12th October 1960. Her Majesty is shown here in the turbine house, accompanied by the Superintendent of the station, Mr. G. Nicholson, Associate Member

An analytical approach to industrial lighting 628.9.06

The development of electric lamps and fittings has been accompanied by the evolution of application techniques. The full assets of easy seeing and suitable environment under artificial lighting depend on an analysis of operational requirements, and proper planning can frequently result in conditions superior to those under daylight. This article is based on an address to a District Meeting at Maidstone on the 7th December 1959. The author is chief lighting engineer of Benjamin Electric Limited.

W. IMRIE-SMITH, B.SC.

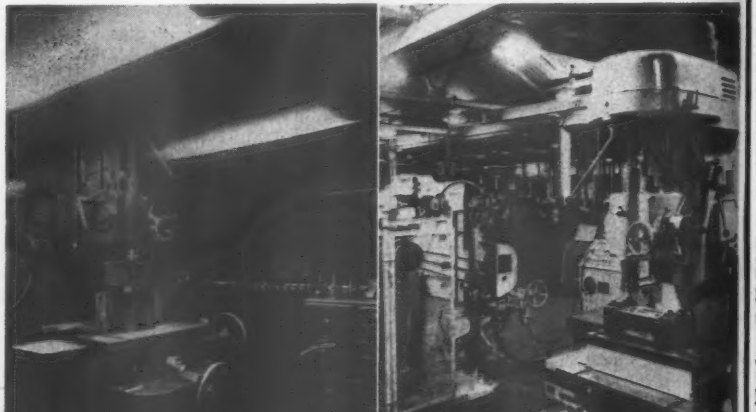
In industry, the artificial-lighting installation is an essential part of the machinery equipment and not just a part of the building like rooflights or windows. Like the rest of the plant, it should have a suitable allocation in the works or production engineer's budget, and be as carefully selected as any other piece of equipment. It is not just a link in the production line; it affects the whole of it.

To achieve desirable results, the lighting engineer has to provide a suitable visual environment with the maximum ease of seeing for many different operatives, and not just a uniform illumination of some chosen value over a specific, but featureless, area. This latter superficial concept of simple area lighting as a *sine qua non* is fallacious.

Subjective and objective factors

The lighting engineer obviously must analyse the situation before he can plan his solution, and a brief outline of some typical steps in this procedure, with their effects on planning, is attempted in this article. Two main aspects are concerned: first, ophthalmic data regarding conditions most acceptable to the eyes; secondly, physical features such as plant arrangement, the building and the objects to be seen.

We perceive detail by its contrast with its background, so we must aim at giving the detail a suitable contrast readily acceptable to the eyes. On the other hand, although the eyes are extremely adaptable to different brightness* levels, they naturally cannot cope with widely different brightnesses at the same time. When strong contrasts are present, the eyes protect themselves by adjusting to the greater brightness and so lose acuity in the areas of lower brightness, an effect known as veiling glare. To avoid such excessive contrasts, it is essential to employ suitable fittings that adequately screen and control the light sources themselves.



1 *Jig borers with light and dark finishes*

The light-finished machine on the right provides superior visual conditions, owing to a better tonal balance, than the dark unpainted machine on the left

Large field of view

Although critical vision is restricted to a cone of 1–1½ degrees, a very important point is that, for our protection, nature has given us a very large field of view. When looking straight forward with the head erect, the eyes cover an angle extending from approximately 50° above, down to about 70° below, the horizontal, and virtually the full 180° of arc sideways. This large solid angle is really a light-catchment angle, and all light within it that reaches the eyes affects their capability. However minute the object of regard, we always have this larger light-sensitive angle round it, so we are concerned with the whole environment.

Surround brightness has been studied by Luckiesh and others with striking results. Tests were made by viewing black test objects on a white background under various levels of illumination, the surroundings beyond the limited background being left dark. As expected, results improved as the illumination increased, until, with the very simple test objects used, the performance curve became stabilized at 40 lumens/ft² or more.

Naturally, with poorer contrasts than black on white, appreciably higher levels of illumination would have been needed to obtain the best results. On repeating the

* Technically, the term 'luminance' should be used in place of 'brightness', but the latter has been employed as being more familiar to the general reader

same tests, but with the lights arranged so that the whole visual field received some illumination, a new performance curve was obtained which revealed two important facts.

First, with the illuminated surround, better results were obtained for all values of illumination on the test object. Secondly, the improvement with test-object illumination did not cease even at 100 lumens/ft^2.

The first result shows that, although not wittingly regarding the darker surround, the eyes were being handicapped by it. Thus, surround brightnesses are important, and for satisfactory visual conditions—quite apart from aesthetics—it is necessary to have appropriate illumination on all surfaces of the environment as well as on the work. This explains why local lighting should not be used without adequate general lighting.

The second result shows that we can reap the benefits of higher illuminations only when we ensure suitably light surroundings, a matter of increasing importance now that quite high illumination values are coming into use. The situation can be summarized as follows: provide a good contrast between the detail to be observed and its background, but limit the contrasts between this background and the environment.

Coloured machinery

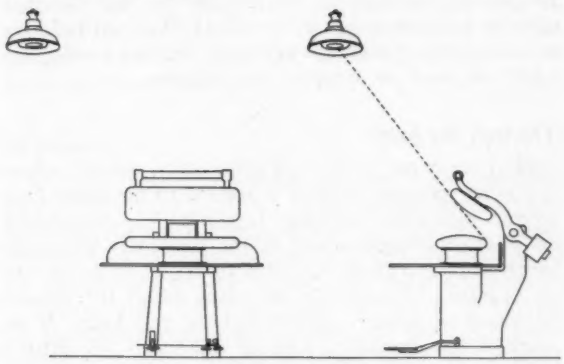
Contemplating typical industrial interiors, it is obvious that, for optimum conditions of surrounds, other factors must co-operate with the lighting if the latter is to be fully effective. However careful the lighting engineer is to ensure illumination on all surfaces in the shop, he cannot possibly spotlight every part of the machinery and structure so as to correct inherent tonal faults. This is where the proper consideration of the use of interior decorations and coloured machinery becomes important.

Suitable light-coloured finishes avoid deleterious contrasts and enhance the visual effectiveness of the lighting, besides providing pleasanter environments. Conversely, masses of dark machines will detract from the conditions that good lighting should provide.

Consider an operative working a well-lit jig borer. The operative concentrates on the work in his machine, yet a large part of his visual field is occupied by the massive top hamper directly in front of him (Fig. 1). What a difference in his visual conditions depends on whether this part of the structure has a light or a dark finish! Experience has shown that appropriately light colourings can be used in industry without the excessive difficulties of maintenance so often envisaged.

Effect of plant lay-out

In planning an installation, the general limitations of the building are obvious, but the dominating features are the plant lay-out and the types of machines or operations involved. Light is not like water that seeks its own level; you can fill the room with light and still be ineffective, the light being obstructed by the machines or operatives, or illuminating them from the wrong side, etc. It is important to remember that, although the illumination over an area may be virtually uniform, the direction of the predominant light changes from place to place and has to be planned so as to conform with the work requirements.



2 *Front and side views of a Hoffman-type press, illustrating the controlling factors in arranging for effective lighting*

As a simple example we may consider the Hoffman type of press used in the clothing and laundry industries (Fig. 2). For the light to reach the pad where the operative has to handle the garments, the dominant light must come from below an imaginary line drawn from the back of the pad up past the front edge of the open lid. This line limits our height, and we have to come far enough in front of the press to obtain a practical mounting height for the fittings, whose positions are thus confined to a comparatively restricted zone. But we are restricted even within this zone. It would be foolish to place the fittings opposite the middle of the press right behind the operative, so we have to move along our zone to fully effective positions near the ends of the press.

Similarly with a lathe, the predominating light must come from the right to facilitate face work, and so on. It may not be the machinery but the type of product that has to be studied, as, for example, in the assembly of large printing presses. Here, although good overhead lighting gives facilities for most of the work, side light—normally to be avoided—has to be added to ensure suitable visibility over tall vertical areas on frames standing near the sides of the shop (Fig. 3).

These are but elementary examples, and one encounters an infinite variety, of differing complexity; but they illustrate how, for the best results, the lighting arrangements must be dominated by the plant lay-out, and not just by what appears to be expedient.

The changing scene

Every case has to be examined individually, as changes may render previous solutions invalid. Machine design is continually developing, and conditions may completely alter although the same operations are involved. There

were recognized methods of lighting pre-war belt sanding machines; since then, their design has changed and a new approach has been adopted.

During the 1920's, aircraft were mainly biplanes, and their assembly shops used an accepted combination of overhead and side lighting to penetrate below the top wings and illuminate the fuselage. By the time the huge aircraft production of the 1939–45 War arrived, the low-wing monoplane construction had been adopted, which obviated the need for side lighting.

The user the judge

Next we come to the real crux of the matter, where our more intimate analysis is applied to the seeing task of each individual operative. It may be very difficult for an observer inexperienced in the particular procedure involved to recognize the detail or object to be seen by an operative or examiner. However expert the lighting engineer, he must recognize that the real judge of his work is the operative, and he must seek the latter's guidance as to what he requires to see.

This is not as easy as it sounds; differences of outlook, long familiarity with the work, or attempts by the operative to ventilate pet theories or preferences often result in a most confused account. By observation of existing conditions, alleged effects, and personal examination of samples, one can generally reject the irrelevant and identify the main details.

Having found the detail to be observed, we next consider its nature and how it responds to light. It is not only a question of how much light it reflects, but of how it reflects—is it predominantly diffusive or specular? This is important, because its appearance under any particular illumination will vary accordingly.

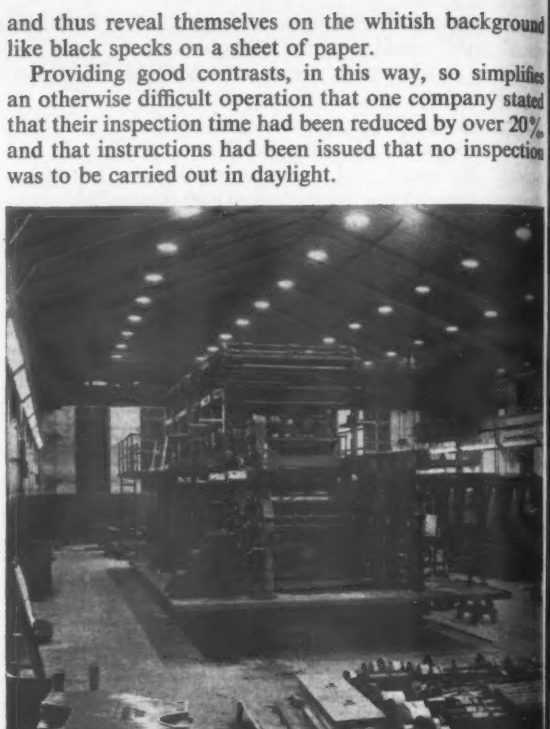
For example, an object with a reflection factor of 50% will not always appear lighter against a background of 40% reflectance. Reflection factors only state the proportion of light reflected, but appearances depend on how the light is reflected, as well as on the amount. Once we have ascertained these characteristics, we are in a position to consider how to apply our light to build up effective contrasts to reveal the detail.

Inspecting polished sheets

Let us consider the inspection department in a rolling-mill where sheets of polished metal are examined for blisters etc. The surface of the sheet is highly specular, whereas the blisters give a more diffusive reflection, besides tending to be a little darker in colour.

Utilizing the specular nature of the sheet as a mirror, we can arrange a white illuminated diffusing panel so that the inspector sees its reflection covering the surface of the metal. Irrespective of the metal—aluminium, brass, copper, etc.—the surface of the sheet will appear to have a whitish finish, the brightness of which can be given a suitable value by the lighting arrangements of our panel. The blisters and defects, which are not so specular, break up the clear reflection obtained over the rest of the sheet and thus reveal themselves on the whitish background like black specks on a sheet of paper.

Providing good contrasts, in this way, so simplifies an otherwise difficult operation that one company stated that their inspection time had been reduced by over 20% and that instructions had been issued that no inspection was to be carried out in daylight.



3 *Tall machinery near the sides of a shop necessitates supplementary side-lighting to augment illumination on the vertical surfaces not reached by the overhead installation*

This supplementary lighting is provided by means of fluorescent tubular lamps in angle-type reflectors along the sides of the shop

If we assume that polished sheets are being examined for scratches instead of rolling defects, different conditions prevail. Both the sheets and the fresh scratches have a specular finish, so that the arrangement mentioned above would be useless.

In this case, although all surfaces are specular, the physical fact that the scratches are small trenches in the surface can be utilized to get a good contrast. If we throw a strong light across the sheet from the inspector's side, the sheet will appear dull, as all reflections are away from him. On the other hand, he will receive strong reflections back from the opposite side of the scratches, which thus stand out clearly as light lines on a dull ground. Obviously, the scratches must run across the direction of viewing, but this limitation can be overcome by rotating the sheet.

Checking scribing

An interesting variant is with a veneer-scribing machine for making match-boxes. The machine pares veneer off a log and scratches a whole series of lines on it so that it can be folded in the box-making machine

It is important to avoid scribing defects, as these would cause stoppages in the box-making machine and loss of time and material in cleaning out and reloading.

The operative has to watch the veneer passing across his front from the scribers and check the presence of the fine scribe lines that are far from easy to see. At first it may seem that we are concerned here with scratches as in our last example, and could light the veneer in the same way. On second thoughts, we realize that, although the damp veneer has a little specularity, both wood and scratches have a more diffusive response to light.

To get our revealing contrast, we have to reverse our former procedure and throw a strong oblique light across the veneer towards the operative, taking care to suitably mask it from his view to avoid glare. Lit in this way, the veneer takes on a certain lightness of appearance (helped by any dampness in the wood), but the far side of the scribe lines—or trenches—are enshadowed and so show themselves as dark lines on a light ground, like pencil marks. Here again, operatives remarked that they could see more easily than in daylight conditions.

Ampoule inspection

This vital subject of analysis for contrast building is inexhaustible, but here is one more example that on the first approach appeared rather formidable.

Glass ampoules—like small long-necked bottles about the size of normal test-tubes—were filled with a clear fluid and sealed off in a Bunsen flame. Occasionally the sealing was carried out too quickly, resulting in glass fracturing off inside, and girl examiners had to inspect the finished ampoules to see that they did not contain any powdered glass. The problem was to reveal a clear glass powder in a colourless fluid in a clear colourless bottle.

The safest way to get light into the ampoule was through the flat bottom, thus avoiding highlight reflections from the cylindrical sides; but this left everything dull, so how could we get our contrast? The clue was that any glass powder present had fractured off, and therefore must have cleavage facets that would be specular.

The answer followed: the inspection bench was provided with a strong narrow beam of light thrown vertically downwards at a convenient position for each girl, together with a neutral-coloured screen as a background. To inspect, a girl grasped the neck of an ampoule, jerked it upside-down and held it vertically in the light beam. Any glass powder was thus jerked to the top of the inverted ampoule, and as it sank down through the fluid its movement caused its facets to give off flashes, like small heliographs, making its detection extremely easy.

The examples quoted above should be regarded as not merely the solution of individual problems, but as typifying the analytical approach in design procedure to provide the best seeing conditions. Its successful application to the many situations encountered in practice depends on the skill of the lighting engineer.

It is hoped that this article will lead to a better appreciation of how much may be lost in simply spreading lighting over a given interior. Although adequate illumination values have to be employed (and future values will be higher), seeing does not depend merely on lumens per square foot—the illumination must be correctly applied. This is the key to the fact that in artificial lighting we are not aiming at copying daylight effects, but to excel them, as has already been done on numerous occasions.

Summary

Analysis of test data shows how perception depends on the brightness relations in the whole field of view, including the environment as well as the objects under observation. This condition calls for the illumination of all visible surfaces and for planning the installation so as to avoid light obstruction from the plant or partitions. To preserve a good tonal balance, all dark machinery should be given a suitable coloured finish; at the other end of the scale, excessive brightness from the light sources can be avoided by the use of correctly designed fittings.

In addition, an analysis has to be made of the actual details to be observed and of how they respond to light, so that local modifications can be made to give them a suitable contrast.

Examples of this detailed analysis show how the proper control of reflection and shadows enhances the revealing power of the light and allows optimum visual conditions to be provided.

Improving television and v.h.f. sound coverage

THE British Broadcasting Corporation has placed contracts for the construction of the building for the new Oxford television and v.h.f. sound broadcasting station to be built at Beckley, some four miles north-east of the city. Two 500ft masts to carry aerials have been ordered, one for this station and one for the new television station near Manningtree, Essex.

These stations are two of several low-power stations which the B.B.C. is building to extend and improve the coverage of its television and v.h.f. sound services.

The Oxford station will improve television reception for about 250000 people in the area including Bicester, Thame, Abingdon and Witney, and will also extend the v.h.f. sound service to more than a quarter of a million people, including those in Swindon, and will give improved reception for a further quarter of a million people. Completion of the station is expected in about 15 months' time.

The Manningtree station will improve television reception for about 350000 people in south-east Suffolk and north-east Essex, including those in Ipswich, Woodbridge, Felixstowe, Clacton on Sea, Colchester and Hadleigh. It is hoped to complete the station during the summer of 1962.

Two experimental learning machines

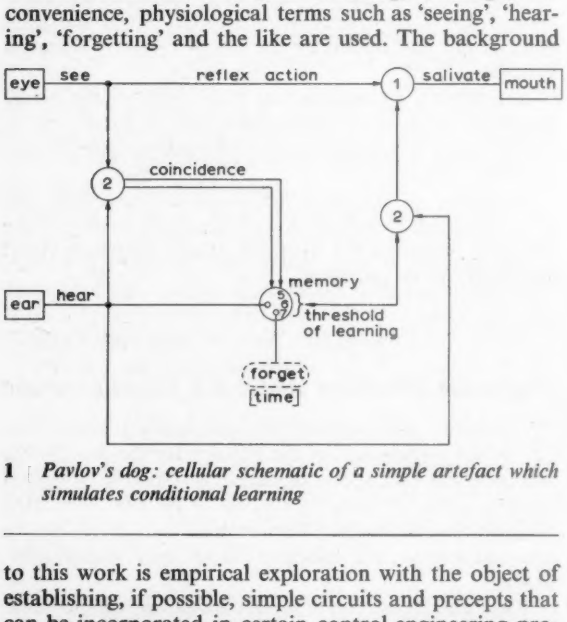
681.142:621.391

The two simple machines described were devised by the author. He demonstrates that such machines behave in a manner which could be described as learning, and that they can be organized to provide a skill not detailed by the designer.

The article is based on a lecture given in Birmingham to the South Midland Electronics and Communications Group on the 23rd November 1959. Mr. Huggins is with Tube Investments Ltd.

P. HUGGINS

THE work described intends no correspondence with the *mechanism* of animal learning, although, for convenience, physiological terms such as 'seeing', 'hearing', 'forgetting' and the like are used. The background



1 *Pavlov's dog: cellular schematic of a simple artefact which simulates conditional learning*

to this work is empirical exploration with the object of establishing, if possible, simple circuits and precepts that can be incorporated in certain control-engineering projects. Learning is defined here as 'a control process which manifests itself in adaptive change in motor behaviour for attaining relatively fixed ends, as a result of experience'.

Pavlov's dog

As an example of a simple learning mechanism, consider the design of a circuit that will simulate one of the classical Pavlovian experiments on learning by association.

The specification for a mechanical Pavlovian dog that can learn to associate the sound of a dinner-bell with meal times can be broadly stated as follows:

Before learning
- i. when food appears, the dog salivates
- ii. when the bell rings, the dog ignores it.

Then follows a period of training (conditioning).

After learning
- iii. when food appears, the dog salivates
- iv. when the bell rings, the dog salivates
- v. the dog must gradually 'forget' as time passes
- vi. ringing the bell without producing any food must bring about a gradual disassociation.

This can be expressed schematically as shown in Fig. 1. The circles represent cells or elements, which can be in two states—live or dead. Associated with the bistable triggers or switches is a threshold number written inside the circle. This indicates the number of excitatory inputs (symbolized by arrowheads) over and above any inhibitory inputs that are required to fire the trigger. The inhibitory inputs are terminated by a small blank circle within the cell. For example, the cell marked 'coincidence' in Fig. 1 will fire only if both 'see' and 'hear'

2 *The mechanistic dog*

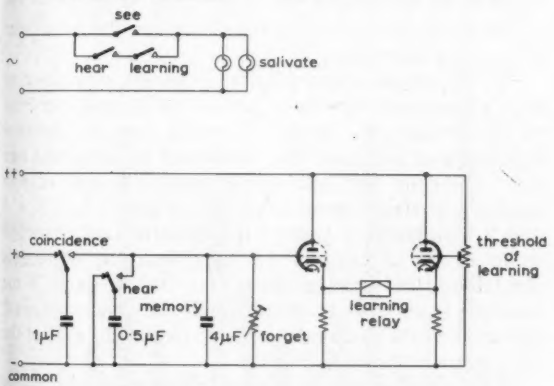
He 'sees' the food with a photocell concealed in his jaw, hears with a microphone and indicates reflex salivating when his eyes (two peanut bulbs) light up

lines are simultaneously—or nearly simultaneously—activated.

In electrical terms, the cells marked '2' are 'and' gates and those marked '1' are 'or' gates. Fig. 2 illustrates the mechanical dog constructed along these lines, the electronic circuit being housed beneath the dog. A simplified version of the circuit is shown in Fig. 3. There are three relays: the 'see' relay operates from a photocell, the 'hear' relay from a microphone, and the 'learning' relay from the circuit configuration shown in the lower portion of Fig. 3. Salivation is indicated by two lamps in the upper circuit lighting up. These operate either when the 'see' relay is activated by showing the dog a bright light, or when the microphone relay is operated by the bell *and* the learning relay has been energized as described hereafter.

The learning relay is energized when the potential in the 4 μF 'memory' capacitor rises to a preordained level, adjusted by the 'threshold of learning' potentiometer. The charge in this capacitor is controlled by:

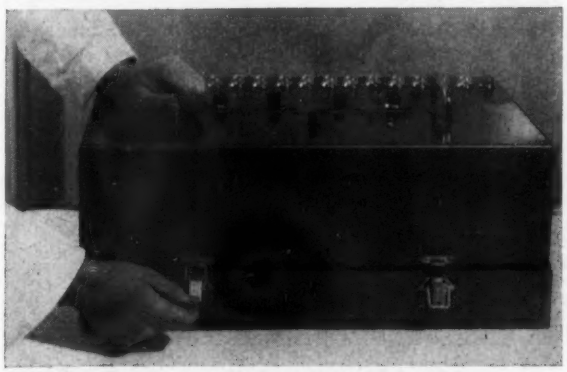
1. The coincidence of bell and food
2. The incidence of the bell alone
3. The passage of time.



3 *Basic learning circuit for a Pavlovian dog*

Condition 1 will exist when photocell and microphone are stimulated simultaneously. The positive charge in the 1 μF capacitor will be transferred to the 4 μF and 0·5 μF capacitors which are then in parallel. Every discrete stimulation will raise the charge in the 4 μF capacitor; and in about seven steps the level will rise sufficiently to energize the learning relay. Condition 2 exists when the dog is being fooled: only the 'hear' relay then operates, thus extracting a charge from the 4 μF capacitor and so reducing the potential difference. Whether the salivation circuit operates in condition 2 is determined by the prehistory, i.e. the net charge in the 4 μF capacitor.

Condition 3 always exists: the potentiometer across the 4 μF capacitor 'bleeds' the charge away continuously so that all stored information is deteriorating with time. The inherent backlash of the valve/relay circuit provides the apposite differential between the threshold of learning and the point at which the artefact unlearns again when fooled.



4 *The games-playing programmed machine*

Learning a strategy

Consider the game where there are 17 counters and two players choose in turn to remove one, two or three counters at a time, the object being to force your opponent to take the last counter.

With (16 + 1) counters, or indeed any number of the form (4*n* + 1), all that is necessary to guarantee a win is (a) not to start first and (b) to counter your opponent's move by always abstracting the complement from four. Thus, if your opponent takes one, you take three; if he takes two, you take two, and so on. To design a circuit that is *programmed* to play to this strategy is not difficult. It can be accomplished with a uniselector and a few relays (Fig. 4). In such a machine, the strategy (skill) is put in by the designer.

It is, however, also possible to build a machine (Fig. 5) which, although cognizant of the rules and the object of the game, contains no inbuilt strategical programme. Such a machine will select one, two or three counters quite indiscriminately. If now we introduce the learning element in the design, it is possible for the machine to be self-organizing to the extent that it will acquire the strategy as it plays.

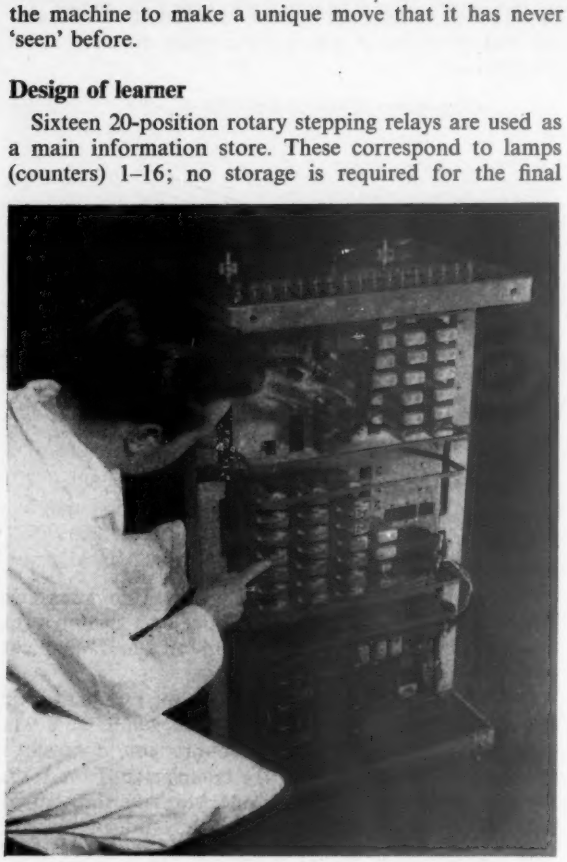
A purely imitative approach to strategy-information storage would be for the machine to remember every game played. When playing, the machine would search its memory of stored games at each move until it identified (if existent) a previous situation that led to a winning conclusion. Such a machine would need a comparatively large memory store and could never intentionally make an original move.

A better approach is to build in the probabilistic aspect so that at any stage of the game the machine can review the state of the game in the light of a reduced aggregation of knowledge culled from all its past games. This flexibility allows the machine to make decisions as to what is *probably* the best move. Also, the way is open for

the machine to make a unique move that it has never 'seen' before.

Design of learner

Sixteen 20-position rotary stepping relays are used as a main information store. These correspond to lamps (counters) 1–16; no storage is required for the final



5 *The games-playing learning machine*

(crucial) lamp. There are two 16-element binary buffer stores. These can be considered as two independent banks of 16 relays, though in practice 16 split-armature Post Office relays were found convenient.

As the game is played, the buffer-store relays record the progress. One buffer store records your moves and the other records the machine's moves in the following way: If you start by taking three, relay 3 of bank A is energized. If next the machine takes two, relay 5 of bank B is energized, and so on. At the end of the game, the information about that game is stored as a pattern (see Fig. 6).

The winning hand (in this instance the machine's) is transferred to the main store, where data accumulate from game to game in patterns such as those in Fig. 7. The height of the black bars indicates the relative advancements of the stepping relays constituting the main store; these are transformed into voltage levels. The machine is so designed that when faced with a choice it seeks the position offering the highest potential.

Thus the machine is designed to include a simple element of goal-seeking. When it is the machine's turn to move, it will search its limited field of choice (is it to take one, two or three?) and make the move that apparently, from past experience, offers the best probability of success.

This action can be understood by following through one game. The store is as in Fig. 7a. Let the player take one. The machine, having a choice, is guided to take two (thus ending on position 3 in Fig. 7a), because there is a higher probability of success on this number than on either of its other possibilities. Let the player then take three. The machine will reply by taking two, coming to rest on the 8th position, which is also a 'lucky number' according to its memory. From this point on, the machine will win, irrespective of opposition moves, because it always obeys the inbuilt rule—'make the most probably successful move based on your past experience'.

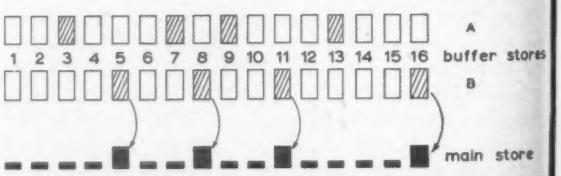
An interesting point is the modest amount of storage required. Sixteen 5-bit stores would register the quintessence of 32 games. Using a 'forgetting' technique that wipes off data as they become superfluous could increase the potential useful information content of this storage even further.

Games-playing experience

The apparatus has been used to explore the behaviour of learning machines.

The learning machine played ten games, commencing with no previous experience, against an 11-year-old child of border-line 11+ grade. The child had no previous experience of the game. The history of the play was like this: The child had first turn (therefore bound to lose against a 'perfect' opponent), and won games 1, 2, 3, 4, 5 and 9. Evidently by game 6 the machine had absorbed more of the strategy of the play than the cleverness available to the child at that point. But in game 9 the machine made a weak move which the child exploited. The state of the main information store at the end of the 10th game is shown in Fig. 7a.

Fig. 7b shows the learning-machine main store after playing ten games against a die. The die was given first move, and the machine won every game except the 6th.



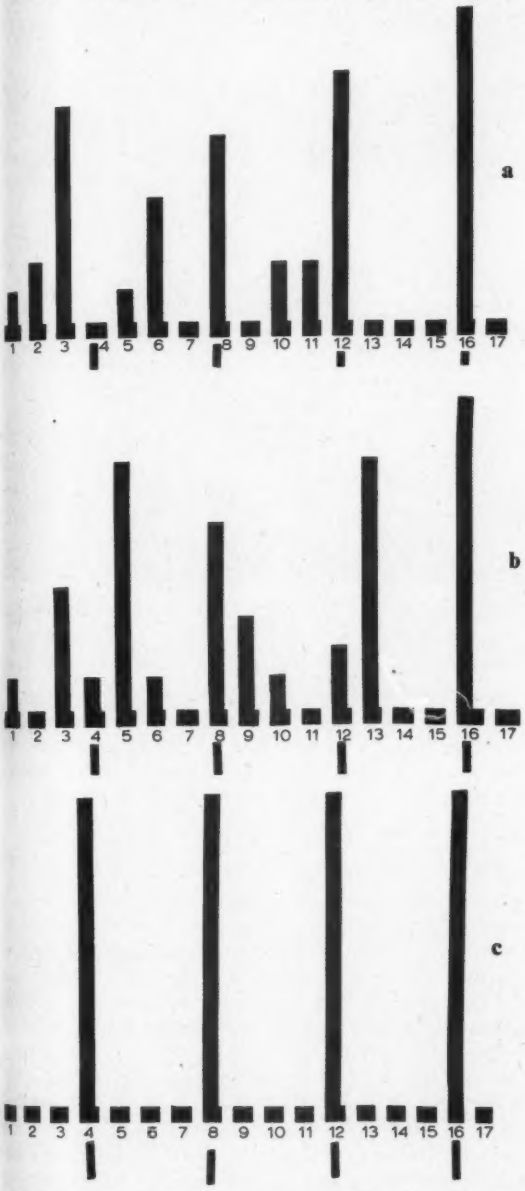
6 *Buffer-storage and data-transfer arrangements for learning machine*

The machine had no previous experience, so evidently won the first game by a fluke. Nevertheless, by the 10th game there is every indication that the machine is playing, as it were, 'intelligently'.

As a matter of interest, the self-taught machine was matched, for an 11th game, against the 11-year-old child.

The child won easily. As a control experiment, the child replayed the machine set up with the knowledge gained from the ten games previously played against the child (see Fig. 7a); the child lost.

Fig. 7c shows the result of matching the learning machine against the programmed machine. The unprogrammed machine was allowed first turn, and the histogram is the result of ten games. The learning machine now obviously has absorbed the strategy and would, if turned loose on a human player, play a perfect game. A human opponent would lose (a) if he started first, or (b) if he allowed the machine to start but made any but the correct strategical counter-moves.



7 *Histograms of information accumulated in main storage after ten games against three different opponents*

An interesting feature of the games played against random numbers is that the learning machine has, in one field of its memory, learnt an incorrect strategy. The games against the expert (Fig. 7c) and the child (Fig. 7a) show that position 12 is correct strategy (leaving opponent to select from five); but Fig. 7b shows the machine has established a preference for position 13. This false presumption has been established because the machine has been winning too easily. In the long run, of course, the true strategy will emerge for position 12 even as it has already emerged for position 8. This experiment shows:

1. That order can be created out of the chaos of random numbers, but that it is a relatively slow process
2. That the machine can be deliberately misdirected by a wily opponent who throws away games; this misleads the machine, whose only designed object is to 'win' (not to learn a clever strategy).

Once false premisses have been built up in the machine, the opponent may exploit the situation. As soon as he does so, the machine is learning the new (correct) strategy, because the probability values are changed. The false strategy is soon masked by a better one.

Summary

The machines described behave in a constructive, self-organizing manner that superficially resembles animal learning. The amount of storage required for learning can usefully be minimized by data-reduction and 'forgetting' techniques. Learning machines provide a skill not specifically detailed by the designer. The skill is abstracted from external source(s) and is stimulated by the richness of such experiences. Machines can abstract this skill from a random input. Self-organizing machines can be misdirected by allowing them to attain their object on false premisses.

High-voltage protective device

At very high-voltages, the use of electromagnetic relays in circuit-monitoring devices can introduce serious insulation problems. A solution to these problems has been devised at the A.E.R.E., Harwell.

The invention replaces the relay by a beam of light and a photoelectric cell. The beam is produced by a neon glow-discharge tube inside a plastic housing, which defines the path for the light beam, acts as insulation, and excludes external light. The circuit being monitored incorporates the neon tube, and is arranged to energize the latter in case of fault conditions. The tube strikes, and the light emitted causes the photoelectric cell to energize an ordinary low-voltage relay, which in turn operates an alarm.

Further information is available from the Patents Exploitation Officer, United Kingdom Atomic Energy Authority, 11 Charles II Street, London S.W.1.

MOSCOW DURING THE SUMMIT

DURING the period in May 1960 when the Summit meeting failed to materialize, two British engineers were in Moscow representing The Institution at the Annual Meeting of the Popov Society on the invitation of its President, Academician V. I. Siforov. The members concerned were myself and Dr. D. A. Senior, who is resident in Moscow as the Scientific Attaché at the British Embassy.

After a 3½-hour journey from London by Russian jet, I was welcomed at Moscow airport by representatives of Academician Siforov, was conveyed to my room at the skyscraper Ukraine Hotel, and soon made contact with Dr. Senior and his charming wife. Mrs. Senior's hospitality during our crowded programme left on me a lasting impression of the great debt owed to Englishwomen all over the world who succeed in creating an English home in the most unpromising surroundings.

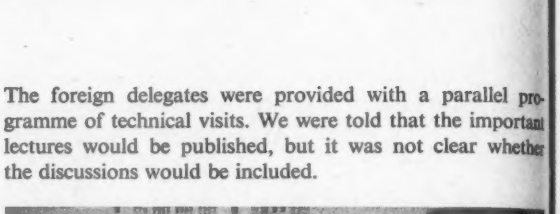
Everything possible was done by our Russian hosts to look after the comfort of the 13 foreign delegations attending the conference. On my return to this country, it was interesting to see the British newspapers and to compare the apparent excitement in the Western world with the calm of Moscow, even though we had been regaled by our interpreters with translations from *Pravda* giving a round-by-round account of the happenings in Paris.

The Popov Society

The A. S. Popov Society is named to commemorate Alexander Stepanovitch Popov, one of the early radio pioneers, and in many ways it is the counterpart of the electronics side of our own Institution. Its size is comparable with that of our Institution. The membership is largely professional, though there are no rigid entry qualifications. It is financed by individual subscriptions, supplemented by grants from the scientific trade unions to cover specific conference expenses.

It has been the recent practice of the society to invite foreign delegates to their main conferences, two of which were held this year in Moscow and Kiev, each attended by about 2000 delegates. The Popov Society is part of a broad pattern of professional societies, dealing with such diverse interests as machinery, radio, instruments, forestry, agriculture and transportation. The presidents of 21 of these societies form the Praesidium of the All-Union Council of Scientific and Technical Societies of the U.S.S.R.

The conference consisted of opening and closing plenary sessions in the Great Hall of Moscow University, two lectures being given at each session by eminent scientists and engineers, with the intervening days devoted to the presentation of about 400 papers, grouped into 16 sections, all sections running simultaneously during 8-hour daily sessions. The foreign delegates were provided with a parallel programme of technical visits. We were told that the important lectures would be published, but it was not clear whether the discussions would be included.



One of the inner roads of Moscow University

Academic visits

The scientific visits we made may be grouped as academic, industrial and social. Our first academic visit was to the Computing Centre of the Academy of Sciences of the U.S.S.R., where we saw two computers of orthodox valve and magnetic-memory type, which are used as general work-horses by other institutes. At this centre, women were extensively employed on the mathematical and programming side.

At the Lebedev Institute of Physics of the Academy of Sciences, we were told that this was one of 15 physics institutes of the Academy, co-ordinated at Council level, and that it carried out fundamental work on nuclear physics, spectroscopy and theoretical physics. A large number of laboratories were seen engaged in fairly fundamental research, with a competent staff working hard in rather crowded conditions but with good equipment.

The Institute of Radio Engineering and Electronics of the Academy of Sciences deals with the fundamental and physical foundation of what we would call radio physics, and has about 200 scientific workers, who, aided by technical assistants, follow their own lines of research associated with problems sent in from industry. The work covered radio propagation in free space and in waveguides, carrier and line

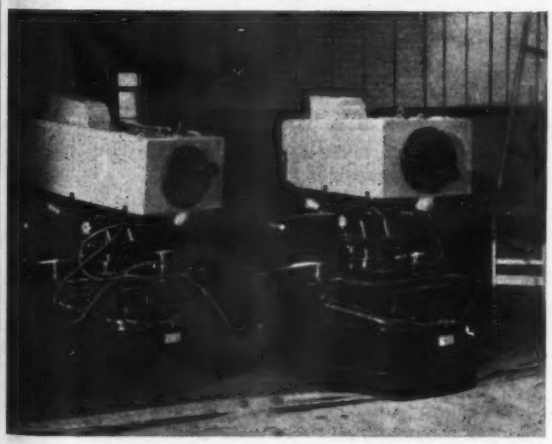
communication, molecular oscillations for the development of frequency standards, transistors and associated semiconductor devices, and vacuum electronics.

The final academic visit was to the Faculty of Physics of Moscow University. It began with a lengthy conference with the Vice-Deacon of the Faculty, who spent over an hour answering questions from all the foreign delegates. We were impressed by the description of the course. It covers a period of 6½ years, one year being spent in practical work. Students enter at about 18, often with one or two years' works experience, and after graduation go on to university research, teaching, industry or industrial research, much as in our own country. There are 300 teachers in addition to the auxiliary staff, and chairs exist in many subjects which we would regard as highly specialized.

Organized work occupies 36 hours per week in the first and second years, decreasing to 10–12 towards the end of the course, supplemented by a great deal of homework. About half the students, and about a third of the staff, are women. In answer to a question regarding standards of examination, we were told that the pass percentage is high (about 90%) because the faculty had the pick of the gold-medal winners from all the secondary schools in the Soviet Union. Touring the building, we noticed the very high standard of lecture theatres and demonstration equipment, with plenty of reading, reference and private-study rooms.

Radio and television centres

Our industrial visits were to the Radio Centre some 20 miles outside Moscow (whence are beamed short-wave broadcasting and communication all over the world and which reminded us of similar establishments in Britain) and to the Television Centre in the city, which transmits two programmes for the Moscow area. Relay stations in 22 towns within about 300km of Moscow are linked to the centre by radio or line. The studios and equipment recalled the early days of Alexandra Palace, and the plans for expansion into new buildings also had a familiar ring.



Experimental colour-television studio

The Russians are full of optimism about colour television. Their techniques and equipment are based on those of the West. The new centre will transmit a colour programme in addition to the two black and white. We were shown the experimental colour studio, which contained cameras and equipment of orthodox design. It was more modern and better equipped than the black-and-white studios being used for regular programmes. There are said to be two million sets in Moscow, and these figures were confirmed by the large number of television aerials one sees on dwellings ranging from old wooden houses to modern apartment buildings.

Television sets on display at the Exhibition of National Economic Achievements

Educational race

We were impressed by the high priority given to education in the Soviet Union and the really equal opportunities for men and women. There is a tremendous zeal for learning, which shows itself not only in the students themselves but also in the encouragement they receive from their families to equip themselves to serve the technological progress which seems to be the main aim of modern Russia.

It is unfortunate that so few of us have the opportunity of seeing this country at first hand and weighing our impressions against the news we find in our daily newspapers. We read much of the armaments race between East and West but all too little of the educational race, which in the long run may be the deciding factor in the preservation of our way of life. Looking at the enormous floodlit university building on the skyline of the Lenin Hills, I felt there was in the Russian people an element of almost religious fervour for education; this fervour, combined with the high percentage of their national income devoted to education, will have a profound effect on the Soviet Union's place in the world.

ROBERT C. G. WILLIAMS

LETTERS TO THE EDITOR

INSTITUTION PUBLICATION PROCEDURES

Dear Sir—There appeared in the June 1960 *Journal*, p. 368, a letter from Mr. W. E. Humphrey advocating the adoption by The Institution of a policy of issuing the *Proceedings* in 'separate' rather than bound-issue form. This suggestion was supported by further letters from members in the August and September issues of the *Journal*; and I undertook, in a letter published in the September *Journal*, to ask the Papers Committee to investigate the matter again.

This they have done. They came to the conclusion that it would be unwise to do away with the publication of the *Proceedings* in its present form. They based this conclusion on the fact, mentioned in my letter in the *Journal*, that the demand for complete issues far exceeds that for the separates; and it should be pointed out here that the facility for obtaining only those papers in which he is interested is at present available to every member. All papers and monographs are issued in separate or reprint form, and the *Journal* each month gives details of the papers and monographs for which application may be made. A disproportionate amount of labour and expenditure would be involved if the 'separate' method were the sole means of publication of Institution papers.

The Committee felt that abolishing the complete issues of the *Proceedings* would not only lead to a serious increase in costs owing to the loss of the advertising revenue, but also result in inconvenience for those members who wish to keep the complete issues and for libraries whose responsibility it is to maintain a full file of the *Proceedings*.

The point at issue, therefore, seemed to the Papers Committee to come down to making it easily possible for those members who wished to do so to extract the papers in which they had a continuing interest and to discard the remainder of each issue.

Accordingly, the Committee investigated the feasibility of a form of binding of the issues of the *Proceedings* which would enable this to be done. It happens that the 'perfect' style of binding, which is used on a large scale in the United States, has now reached a stage of development which would make it suitable for use by The Institution for its publications. In 'perfect' binding, the 'signatures' (or 32-page collections) of pages as they come off the normal printing machine, each consisting of a single fold of sheets, are abraded along the folded edge so that each page is separated individually, and then the bundle of separate pages for an issue is glued together by an adhesive applied over the abraded edges. The cover is then attached to the bundle, and the nature of the adhesive is such that the publication will stand normal wear without ill effect. However, because each page is individually attached to the adhesive, it is a simple matter for the pages of any individual paper to be pulled away from the adhesive, clipped together and filed by any member who wishes to do so.

As regards binding of the complete volumes of the *Proceedings*, it is possible to use the 'perfect' binding system to hold together all the issues in the manner described above. Alternatively, the 'perfect'-bound issues can be stitched for annual binding, if so desired.

We are assured that 'perfect' binding will stand up to all ordinary conditions of use. In the interests of economy and speed, it would be necessary for the *Journal* also to adopt this style of binding. Accordingly, investigations are being made with a view to the system being adopted for the *Journal* and *Proceedings* as soon as possible. The start of the new style will depend on the time necessary for the acquisition by our printers of the necessary machinery etc.

It is felt that this proposal, which has received the approval of the Council [see p. 716], is in the best interests of members and that both those who keep the complete issues and those who wish to retain only those papers in which they are interested will find the new system satisfactory. The new style of binding would not be affected by any rearrangement of the Parts of the *Proceedings*.—Yours faithfully,

O. W. HUMPHREYS, C.B.E., B.SC., VICE-PRESIDENT
Chairman, Papers Committee

Soval, Maxwell Road
4th November 1960 Northwood, Middlesex

NATIONAL CERTIFICATE COURSES

Dear Sir—Thirty years ago a boy left grammar school after three years of secondary education, entered the S.2 National Certificate Course at the age of 14 and progressed through S.2, S.3, A.1 and A.2, passing the A.2 examination at the age of 17.

The boy is now headmaster of a selective-entry secondary technical school and is intrigued to discover that boys leaving his school at 16 or 17 years of age, after a five-year secondary course, must begin at S.1 unless they possess a magic key bearing specified G.C.E. labels.

What has happened?

(1) Are pupils of 17 today considerably less well-educated than their 14-year-old counterparts of 30 years ago?
(2) Is the standard of the S.1 examination considerably higher than it was 30 years ago?
(3) Are the Joint Committee for National Certificates making absurd demands in requiring G.C.E. passes for exemption from S.1?

My own opinion is that the answers are very definitely (1) no, (2) no, and (3) yes.

A past pupil of mine obtained 100% in his S.1 mathematics examination this year. Fine! And how futile! He could have passed S.1 mathematics two years ago, and S.2 mathematics when he left school a year ago. Instead, he is being encouraged to develop 'go slow' habits through an undemanding S.1 course, he may have difficulty in stepping up the pace in the later years, and he may be overtaken by marriage and

family responsibilities before he completes the course. Are we not going to increase the 'mortality' rate in National Certificate Courses?—Yours faithfully,

H. CAMPBELL, B.SC., ASSOCIATE MEMBER
Headmaster
Grange Park Secondary Technical School
Broadway
St. Helens, Lancs.

17th October 1960

[The Chairman of the Joint Committee for National Certificates in Electrical Engineering, Prof. M. W. Humphrey Davies, writes: The example quoted above obviously refers to a gifted pupil who, lacking the opportunities of modern selective secondary education, took full advantage of night school to achieve the remarkable success of passing the A.2 examination at the age of 17. There must be few who have equalled this achievement.

Nowadays a boy of such ability would normally stay at school until 17 and, if he had been rightly advised, would take the General Certificate of Education at 'A' level and would qualify for admission to a course leading to a university degree or Diploma in Technology (Engineering). Those less gifted may stay at school until they are 17 without obtaining any passes at 'O'-level G.C.E. relevant to engineering education, and even when they are admitted to the S.1 year they undoubtedly contribute to the very high failure rate that is so noticeable in these courses.

The pupil who obtained 100% in his S.1 mathematics examination is surely the type who should have entered for the G.C.E.: what a pity that he was not given this opportunity! If pupils are not guided into the right courses, they will inevitably meet with frustration.]

[The Minister of Education's remarks in the House of Commons on the 7th November 1960 (*Hansard*, col. 683–684) appear to relate to the problem outlined by Mr. Campbell; the announcement which has been promised 'before Christmas' may throw more light on this subject.—Secretary I.E.E.]

JUNCTION TRANSISTORS AND THEIR APPLICATIONS

Dear Sir—I would like to add a few words to those written by Mr. O. D. Robinson in his letter published in the October 1960 *Journal*, p. 598.

Having spent some time combating the term 'non-ohmic' when used to describe the characteristic of a resistor which becomes of lower ohmic value the higher the applied voltage (and having had some satisfaction in seeing this illogical term dropped in favour of 'non-linear resistor'), I notice that we now have two more strange terms creeping into the semiconductor jargon and both in similar vein.

The first of these terms is 'ohmic contact'. All contacts (like all resistors) are ohmic, and while therefore this term is not incorrect it conveys nothing of the real point, which is that, unless correctly made, the contact to a semiconductor device may have the properties of a rectifier and offer a resistance which depends for its value on the direction of current flow. A correctly made contact would then, in this context, be better described as a 'non-rectifying contact'.

The second of these terms is 'negative resistance'. This conveys the idea of a circuit component having a voltage drop of the opposite polarity to that which would normally be expected from a knowledge of the direction of current flow. In fact, the term is being used to describe the characteristic of a semiconductor device when used over that part of its range where it becomes of higher ohmic value the higher the applied voltage, i.e. where it displays a characteristic the opposite of that shown by what is now called a 'non-linear resistor'.

Quite obviously, there can be no such thing as negative resistance, and a better way to describe this characteristic would be to say the device has a positive voltage coefficient, with negative voltage coefficient used for the 'non-linear resistor'. This would be in agreement with positive and negative temperature coefficients at present used to describe the characteristics of resistors which respectively increase and decrease resistance with increase of temperature.

Resistance then may increase with voltage (as it does in the case referred to), and this device should be described as having a positive voltage coefficient of resistance—not as having negative resistance. Resistance may decrease with voltage (as it does in a silicon carbide resistor), and this resistor should be described as having a negative voltage coefficient of resistance—not as being 'non-linear', and certainly not as being 'non-ohmic'.

Resistance may also increase with frequency (the well known skin effect), and this could be described as a positive frequency coefficient of resistance, against the day when, if we have not already got it, we have the opposite and will need to use the term 'negative frequency coefficient of resistance'. Resistance may also depend on the direction of current flow (the rectifying effect), but this is already covered by the term rectification ratio. Resistance also depends on the physical state of the specimen (temperature for example), and once again positive and negative coefficients of resistance may be used for temperature or any other physical condition.

Summing up my views on this subject, I believe as follows. All resistors (and all contacts) obey the inviolable Ohm's law and are therefore ohmic and can only be positive in value. The only absolute way to determine their resistance is by direct measurement of voltage and current, and this having been done the quotient gives the answer applicable to the specimen with the various relevant factors as they were at the time of the test and in the knowledge that a change in any one or more of them may either increase or decrease the resistance but will never make it non-ohmic and will never give it a negative value.

If I may conclude on a note similar to that used by Mr. Robinson, I would say that my own pet hates outside electrical engineering are on-loading and off-loading when used instead of loading and unloading!—Yours truly,

R. WELLS, MEMBER
76 Sidney Road
Walton-on-Thames, Surrey

2nd November 1960

Sir—The question What is an electron? has been raised in the correspondence, on p. 598 of the October 1960 *Journal*, on junction transistors and their applications. May I refer to a difficulty which I encounter in understanding the nature

of the electron? Experiments using such apparatus as the Crookes tube and the cloud chamber give the impression that the electron is a real particle having an actual existence in the world of experience. This is contradicted, however, by the conception of the electron as a subatomic particle, since the subatomic world is inaccessible to experience.

If, for instance, I touch a piece of copper, the process of touching relates to the copper, not to the electrons and other elementary particles of which the copper is composed. It is impossible for me to touch the particles. These are the underlying cause of the macroscopic properties and qualities of the substance, but they do not themselves possess these attributes, otherwise they, in their turn, would require to be further analysed into elementary constituents.

There seems to be some fundamental confusion between the electron which undoubtedly occurs in the vacuum tube and the 'electron' which rotates in its orbit around the atomic nucleus. It would perhaps be of some assistance in following the mode of operation of the transistor, and other devices, if it could first be established whether the electron belongs to the world of experience or to the subatomic realm. It cannot well belong to both.—Yours faithfully,

H. G. GANGE, GRADUATE
42 Glandon Drive
Cheadle Hulme
9th November 1960 Cheadle, Cheshire

PROGRESS IN DIELECTRICS—VOL. 2

[Mr. C. G. Garton was invited to reply to Dr. J. B. Birks's letter published in the November 1960 *Journal*, p. 647; his reply appears below—Editor]

Dear Sir—I am sorry indeed that Dr. Birks should regard my review in the August 1960 *Journal*, p. 501, as highly critical of his contributors' efforts. It was not so intended, and I think he must have mistaken for dispraise a brevity forced on me by limited space. The review, which exceeds the Editor's preference, contains 18 sentences: an average of three for each article in the book. This leaves little scope for detailed explanation.

But a reviewer must not write advertisements. His main function is to criticize and compare. It seems to me beyond question that somewhat less real progress is recorded in this second volume, compared with the first. This does not surprise me. Although I agree with Dr. Birks that there is great activity in the field of dielectrics, I would put the annual progress worthy of permanent record lower than he does. I had hoped my review made it clear that I was criticizing the general policy of publication, not limited to Dr. Birks's volumes, which is tending to replace the timely monograph by the automatic annual review. I think I am not alone in doubting the wisdom of this development. Perhaps it was unfair to make the point in a review of a particular book.

I am a little surprised that Dr. Birks should define his aim as '. . . to summarize . . . the present state of knowledge, . . . whenever . . . obtained . . .' This seems to me the function of a monograph. It makes the title 'Progress in dielectrics' rather misleading, and I was misled. I would still prefer reviews of progress to be *critical* reviews of reasonably recent progress.

Apparently Dr. Birks, deciding that I was hypercritical, has mistaken even my appreciation for damning with faint praise. It is not so. When I wrote of two articles that they were 'very well done' and '. . . . the most original . . . very full', I meant just that. It is not useful to write in hyperbole; even the writers of Genesis were content to say that the Creation was 'good'.

When I described a third article as a brief introduction, I meant no more than that it dealt substantially only with the mathematics of reflection, refraction and transmission in artificial dielectrics. It is a statement of fact, not of criticism, that it does not consider the diffraction pattern of actual structures, nor their energy losses, nor in any detail their construction and application.

Dr. Birks can, I think, claim originality for his discovery that I inhabit an ivory tower. The article on the technology of manufacture of high-permittivity ceramics is a very good and full account. I merely indicated a mild doubt whether it was in the right company. On reflection, I do not see where it would be better published, so will engage a room on a lower floor.

On two points, though they are of no great importance, I will join issue with Dr. Birks.

Incident protons ionize densely along the whole of their path. Incident neutrons cause dense ionization at intervals spaced very sparsely, on an atomic scale, where they collide with a nucleus and generate a secondary proton. The difference may or may not be important, but is obscured by the wording in the article.

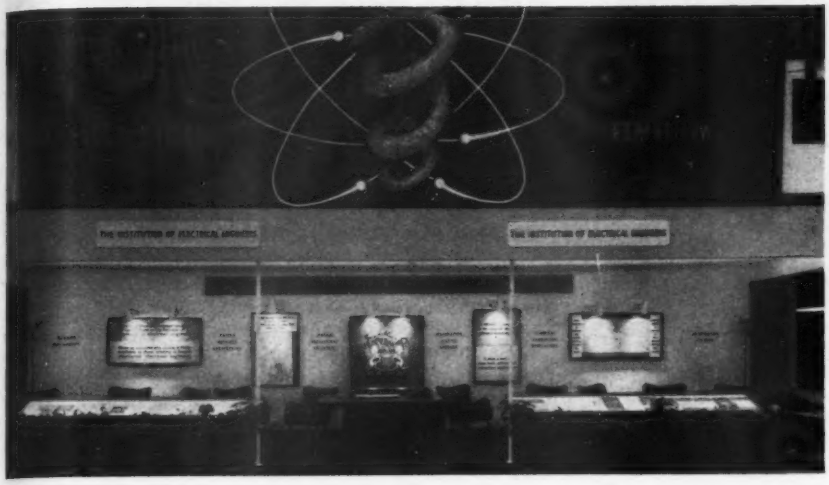
I accept Dr. Birks's assurance that 'telekilocurie' exists, but inquiry of a group including two present members of the isotope staff at Harwell, a past member of the Harwell courses on isotopes, and a fourth with a recent doctorate in nuclear physics, produced only scepticism and inability to suggest any probable meaning. It is in any case a barbarous word and fails in the primary purpose of construction from Greek—that it should be self-explanatory. Three Greek roots might produce 'tele' as an English prefix. They mean respectively 'distant', 'perfect' and 'purposive'. Which can qualify 'thousand', and what does the result mean? My 'If [it] exists . . .' was an invitation to claim a misprint. I will substitute 'Although it exists, it ought not'.—Yours faithfully,

C. G. GARTON, MEMBER
The Electrical Research Association Laboratory
Cleeve Road
25th October 1960 Leatherhead, Surrey

HARWELL AND WINFRITH

To correct a wrong impression given in the article 'Report from Winfrith, 1960' on p. 594 of the October 1960 *Journal*, it should be pointed out that the Winfrith Atomic Energy Establishment of the United Kingdom Atomic Energy Authority has been set up as the Authority's principal centre for research into the physics and basic engineering technology of nuclear-reactor systems. There is no intention that Winfrith should supersede the Atomic Energy Research Establishment, Harwell, in the Authority's much wider fields of research, e.g. in chemistry, metallurgy, and theoretical and nuclear physics.

Third international conference on medical electronics, London, July 1960



The doctor and the engineer

In accordance with decisions taken at the second Paris conference in 1959, the Electronics and Communications Section of The Institution agreed to organize a third conference on medical electronics in London this year, together with an associated exhibition. This move was supported by the International Federation for Medical Electronics, which actively co-operated at all stages of the preparations, and the conference and exhibition were held at Olympia from the 21st to 27th July 1960.

There were altogether some 760 registered members of the conference, including 227 oversea visitors from 25 countries. It is generally agreed that this represents a satisfactory attendance, being almost double that for the previous year. In the early stages of planning it had been hoped that many more would be attracted, especially the medical practitioners. Unfortunately, the ideal of a free interchange of ideas between engineers and the medical profession as a whole has not materialized, and, as one engineering journal expressed it, we were preaching to the converted. The situation may not be as bad as it seems, however, since the 8000 visitors to the exhibition are ten times the present roll of the 'converted' in this country.

During the six days of the conference, the number of lectures, papers and contributions numbered almost 150, covering a range of subjects and techniques vast enough to discourage any description of medical electronics as 'yet another specialization'. It is impossible to present a completely balanced review in one article, but I hope that some indication of the present interests in this field will be gained from what follows.

Image intensification

The X-ray tube was probably the earliest electronic device to aid medicine. Today the importance of radiology is acknowledged, but so too is the danger inherent in its indiscriminate use. Image intensification to reduce patient dosage is becoming more common, and a communication by R. L. Beurle, N. C. Kennedy and N. A. Slark compared the available methods. They conclude that, although solid-state intensifiers are simple, their high noise and long persistence leave the direct-viewing intensifier and the television intensifier as the preferred methods.

According to L. E. Flory, colour television is being used increasingly for medical teaching in the United States. It has also been adapted as a powerful research tool by C. Berkley, V. K. Zworykin and D. Geduldig. The contents of living cells are transparent to visible light, but have characteristic ultraviolet absorption bands. The specimen is therefore illuminated in turn with three different wavelengths of ultraviolet light, and the optically magnified images are transduced by a special image-orthicon. When displayed in sequence on a colour tube, the primary colours represent the incident radiations, and the eye, fusing the images, sees a moving picture of the cell, with its components revealed in characteristic tints.

Longer wavelengths, including the microwave band, are also absorbed by living tissues, and most speakers covering this phenomenon dealt with the damage caused by its heating effects. A cautionary note was struck by Prof. R. L. Carpenter, D. K. Biddle and C. A. Van Ummersen, who produced evidence supporting the unorthodox view that permanent damage may be caused, especially to the eye, through the cumulative effect of repeated exposures to fields lower than the official danger level of 10 mW/cm^3.

Heart-beat monitoring

Intense ultrasonic vibrations can also destroy living cells, and neurosurgeons use them to produce controlled lesions deep in the brain. W. J. Fry explained that the sharp focusing that can be obtained achieves this effect without disturbing the overlying cortex.

Using pulses of lower intensity, and sound-ranging techniques, Prof. I. Donald and T. E. Brown have produced cathode-ray displays representing cross-sections through the abdomen. Some show recognizable echoes from a foetus before the twelfth week of pregnancy, a result that radiography could not equal. At the conclusion of pregnancy, the foetal heart-rate is a sensitive indicator of its own well-being, and obstetricians are attempting to monitor it throughout labour.

According to E. H. Hon, the normal range is 120–160

University College Hospital Medical School exhibit at the International Medical Electronics Exhibition, showing (centre) post-partum uterine action recordings and (right) intra-uterine 'radio pill' recordings

beats/min between contractions. Using a special electrode attached directly to the foetus, he obtains a 50–100 μV electrocardiogram (e.c.g.), free from the interference of the maternal e.c.g. and well above the noise level. After amplification and filtering, the residual sharp 'QRS' spikes drive a cardiotachometer, which indicates rates directly on a meter or provides a write-out on a paper chart.

Respiration research requires rapid analysis of the gas-exchange processes occurring during the breathing cycle. Several physical methods were described, one of the fastest being the scanning mass spectrometer developed by K. T. Fowler and now in commercial production. The respired gases are continuously sampled from the bronchial tree or lips, some being leaked to an ion source within the evacuated chamber. M. J. H. Stallard described how the accelerating potential is varied so that the focal points produced by the magnetic field—each one specific to a particular gas—are scanned across a collecting electrode. The ion currents are proportional to the quantity of each gas, so that after amplification they can be displayed as pulses on a sweep derived from the accelerating potential and calibrated in terms of mass.

Radio-isotope distribution

J. R. Mallard and C. J. Peachey contributed a description of their system for displaying pictorially and quantitatively the distribution of radio-isotopes *in vivo*. The patient's couch is mechanically scanned beneath a fixed scintillation counter; and, whenever a chosen number of pulses have been detected, a fixed inking system stamps a sheet of paper attached to the couch with a colour automatically determined by the mean count-rate for that position. When the couch raster is completed, the distribution of coloured areas on the paper represents in a striking fashion the pattern of isotope concentration in the organs beneath.

The electrometer valve was developed largely to meet the needs of the atomic physicist. Now the electro-physiologist is using it to measure the complex electric fields surrounding, and even within, single living nerve cells. He is often forced to use liquid-filled glass micro-electrodes having impedances of up to 10^8 ohms, and he dare not allow grid current to exceed 10^{-12} amp for fear of damaging the preparation. These and many more problems were discussed by M. H. Evans in his exhaustive specification for a general-purpose biological amplifier.

E. Gordy and P. Hasenpusch described a head amplifier designed for these applications. They used 11 transistors and one electrometer to achieve a gain of unity—and near-perfect characteristics. Although the pure transistor amplifier has a poor reputation for high-input-impedance purposes, the advent of the electrostatic carrier-frequency amplifier, based on the voltage-dependent capacitance of back-biased silicon diodes, is a major break-through. A commercial version with an input impedance of 400 megohms was discussed by A. Elmqvist.

Direct aids to patients

Most of the papers mentioned so far concern research or diagnosis, but medical electronics is potentially capable of giving some patients direct help and comfort. The deaf aid (that early stimulus towards miniaturization) was for years the sole example, but the transistor has initiated a revolution in component design and in techniques, so that more rapid progress in this direction is possible.

The artificial voice developed by R. V. Tait is used to restore speech following laryngectomy. Of remarkable simplicity, it consists of a transistor blocking-oscillator driving a hearing-aid earpiece, all components being moulded into a standard upper dental plate. Despite its fixed amplitude and frequency, mouth and tongue movements produce loudness modulation, and by tuning, the oral cavities can accentuate appropriate harmonics. Thus the original mechanical buzz becomes a recognizable, though monotonous, voice.

Earlier hopes that ultrasonic radar could assist the blind were frustrated by the bulk of the apparatus required and the difficulty of transforming visual information into a form meaningful to the senses of hearing or touch. In his lecture, R. L. Beurle surveyed past attempts and examined the prospects of future schemes. An 'acoustic lamp reader' developed by H. A. Dell and K. Holford is helping blind telephone operators to deal with the new private branch exchanges that use flashing-light codes.

Reviewing the problems of powered-limb prosthesis, Brig. N. A. M. Swettenham explained that pneumatic motors supplied from compressed-gas cylinders offer the best chances for successful development. Existing experimental motors can make an artificial or paralysed arm perform simple movements, the patient using some convenient undamaged muscle to actuate the controls. A long-term project is the control of a prosthesis using existing neuromuscular potentials that can be varied by an act of will.

Heart pacemakers

Spare parts for the indefinite maintenance of vital functions are also reserved for the future, but during and immediately after surgery it is sometimes possible to provide a temporary control system to maintain life while the organism recovers. An established example of this type is the cardiac pacemaker, which is available in several commercial forms.

Most of these are external units for use in theatre or ward, but one described by A. Elmqvist is designed for implantation within the chest wall for periods up to several months. This transistor stimulator is moulded in plastic, and makes contact

via a lead inserted directly in the myocardium. The heart action is triggered at about 70 beats/min by means of 2 volt pulses lasting 2 millisec. Power is provided by a nickel–cadmium cell that is recharged as necessary by induction from outside the body, through an inbuilt pick-up coil and rectifier.

Dealing with the control of blood pressure during surgery, J. H. Green explained how a blood-pressure follower can maintain a preset value by regulating the automatic intravenous infusion of hypo- or hypertensive drugs. The follower is a device that automatically applies a rising pressure externally to a finger, while a transducer detects the moment at which local arterial pulsation disappears. The pressure at this end-point is then equivalent to the systolic pressure.

The electroencephalogram (e.e.g.) offers a method of monitoring depth of anaesthesia, since clinical signs often fail to show the transition between conscious and unconscious states. The presence of cortical responses evoked by flashing lights applied to the eyes could decide the issue, but free-running alpha rhythms at about the same frequency as the stimulus often mask the effect.

A simple display that shows a response if it forms at least 20% of the signal, and which resolves a frequency difference of 0·02 c/s, was described by J. Clutton-Brock. A television-type raster is applied to a long-persistence cathode-ray tube, the line frequency being locked to the stimulus. When the amplified e.e.g. is displayed as intensity modulation, the appearance of vertical bright bands on the screen with the expected latency indicates an evoked response, and consequently some degree of consciousness.

Recording techniques

The above example is one of many possible ways of displaying biological variables. The traditional analogue system of amplitude against time is still valuable, but more-refined methods are being increasingly applied. A concise review of current practice was given in a paper by Prof. V. A. Kozhevnikov, who listed the various forms of frequency, correlation, and probability analyses, together with the automatic devices for performing them.

An electronic multi-bed ward thermometer (foreground) shown by the University of Edinburgh Medical Physics Unit at the International Medical Electronics Exhibition

The desirability of putting records directly on tape was stressed by G. H. Byford. This enables the data to be subsequently processed in many different ways, some of them perhaps unthought of at the time of the experiment. The various averaging techniques advocated for extracting a repetitive signal from noise depended on other storage methods, ranging from the barrier-grid storage tube used by R. Cooper and W. Grey Walter to H. W. Shipton's electrostatic drum. The multiplicity of methods was highlighted by one speaker, who claimed to have invented an obscure system called Sara (still another response averager).

Data analysis by digital computers was also discussed thoroughly, as was the conversion of analogue records into binary digits. But, as somebody remarked, the final results usually have to be plotted as a graph so that the investigator can recognize them.

The general preoccupation with the accumulation of masses of records led M. A. McLennan to point out the essential difference between data and information. The economic use of power, volume and time that is forced on the worker in space physiology has resulted in this distinction being made. Telemetry channels are too precious to be used for transmitting continuously the normal e.c.g. of a space explorer. Since 'only change is news', some selection must be performed at the transmitting end, but as this calls for more instrumentation within the vehicle this policy cannot be carried too far.

Radio pills

An example of telemetry over shorter distances was disclosed in a paper by W. J. Perkins and J. E. Lewin. This involved the transmission of an e.e.g. from a cat that was free to perform various tasks unencumbered by trailing wires. The complete transistor amplifier and pulse-frequency-modulated transmitter were carried without difficulty on the animal's back.

Operating over even shorter ranges are the now familiar radio pills, or endoradiosondes. An addition to the usual variables that can be radiated from the gastrointestinal tract was reported by Prof. R. Stuart Mackay. It is hoped that his new pill will locate internal bleeding, using as the physical property to be transduced the dielectric constant of 5000 displayed by red blood cells.

Another pill, described in a paper by J. T. Farrar, V. K. Zworykin and C. Berkley, has reduced size and almost unlimited life, through the simple expedient of leaving out the battery. The energy is supplied by an external transmitter delivering 3000 pulses/sec, each of 400 kc/s. Between the pulses, the pill's circuits ring at a different frequency, determined by the position of a ferrite slug in the tuning coil. Since the slug is attached to a pressure-sensitive diaphragm, this pill transmits pressure data, which are obtained from the output of the external f.m. receiver that is gated between energizing pulses.

It has not been possible to comment on the papers dealing with the use of computers for diagnosis, for medical-record storage, and for a multitude of other tasks. Likewise, the experts on biological control systems, their analogues and their equations, have received no mention.

However, as the next conference is but six or seven months away, I believe there will be another opportunity in New

York to hear some of the material presented at Olympia. If past experience is a guide, it is too much to expect all branches of medical electronics to make world-shaking progress in the course of 12 months, but some repetition will be tolerable if the rest achieve the standards that we enjoyed this year.

A. S. VELAIT

Content of undergraduate textbooks 021.3 (078.5)

Although most people recognize the qualities and virtues of a good product, few are able to justify their preference. While it is generally recognized that personal likes and dislikes have an important part in the decision, there is no accepted code by which it is possible to say why, for example, one book is excellent and another inferior. This article attempts to formulate some general concepts on the principles that should guide an author writing an electrical-engineering textbook intended for undergraduate students of electrical engineering.

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P. F. SOPER, PH.D., B.SC.(ENG.), MEMBER

An intending author suffers a considerable sacrifice of time and energy while collecting and collating the data. All the more reason why every effort should be devoted to ensuring, for the embryo textbook, a wise choice of subject-matter, a good arrangement, and a satisfactory literary style.

A modern university course should be judged less by the facts it dispenses than by the training provided for the mind. By training the mind, a course gives breadth and cutting edge to the intellect, while at the same time the student gains some knowledge of the technology. This knowledge of the technology acquired during the educational training is, however, of secondary importance. An undergraduate textbook should be more than a mere compilation of facts.

An able author should have sufficient experience to be able to discuss some of the problems of the subject, giving an indication of the growth and range of the technology. A range of subject-matter beyond the undergraduate's need may sometimes defeat and confuse an average student; this student is, in any case, frequently industrially immature.

The large amount of material frequently included in textbooks usually arises from an author attempting to satisfy the requirements of an examination syllabus. In the past these syllabuses have been enlarged to include new knowledge, but the growth has so overloaded the syllabuses that the teaching has become superficial. In many cases this overloading has been due to those lecturers who are narrow specialists making up part of the syllabus.

Specialist lecturers, like the specialist textbook, may be a source of trouble for the immature student, but if the lecturers are widely read they can often use their knowledge effectively as a background to the essential training of the mind. Since it is essential that all subjects of a given undergraduate course should be taught in close relationship to one another, the textbook should make the reader aware of work in associated subjects and of any social implications.

A good book should provide, among other things, intellectual enjoyment, develop logical thought in a simple manner, and stimulate the reader.

Aim and scope

To cover the subject-matter in a manner adequate for the purpose of undergraduate instruction, the text should have a definite aim, with a restricted scope. The material should be so presented that alternative methods and procedures are brought to the attention of the student, thus giving him a critical outlook in his studies. At the same time, the subject-matter should be presented in a logical order, in which a concept or context is not used until it has been explained.

Sometimes the subject-matter is presented historically, but this frequently introduces a lot of extraneous material which has become of purely academic interest. The logical sequence will facilitate reading and resultant assimilation. The order of the chapters should provide logical development with continuity of treatment.

In this way the book could, as it should, encourage self-help and eliminate the present tendency to spoon-feed the reader. The text should assist the reader to keep in mind the kind of information he or she is reading, whether it is experimental fact, fundamental concept, derived relationship or explanatory discussion. Every opportunity should be taken to give the text reality by indicating possible practical applications of the various topics.

A sense of proportion, in the order of magnitude of the quantities involved, can be presented by means of carefully chosen numerical problems and exercises. This inclusion must not make the arithmetical work too involved. In this connection, it is useful to insert representative values of components on circuit diagrams used to illustrate the text (Fig. 1).

Conventions

Great care must be taken when preparing the text and diagrams to ensure that only standard conventions, symbols, units and abbreviations are employed. In the teaching of theory, not only must these conditions be fulfilled, but it is advisable that all vector diagrams should

be drawn with the reference vector horizontal. This is the same convention as used in the construction of the Argand diagram.

The actual construction of each vector diagram should follow systematically from conventions clearly indicated, not assumed, on the associated circuit diagrams. There is also a very strong case for insisting, for 3-phase circuits, that the associated circuit and vector diagrams should have one of the phase vectors drawn along the horizontal axis. The common practice of drawing the first, or red, phase in the vertical direction is deprecated, since this phase is conventionally taken as the reference vector.

Illustrations

There is little point in including illustrations of actual plant and apparatus unless the inclusion assists the reader in his appreciation of the principles of the subject. Such illustrations tend to date the text and, in any case, add an unnecessary cost to the production. If illustrations must be included, they must be of the highest quality. In general, adequate manufacturers' catalogues are now available with suitable pictorial illustrations of actual plant and equipment. The inclusion in textbooks of suitable diagrams, showing the essential constructional features, may often provide visual help in understanding the theoretical discussion.

Problems and exercises

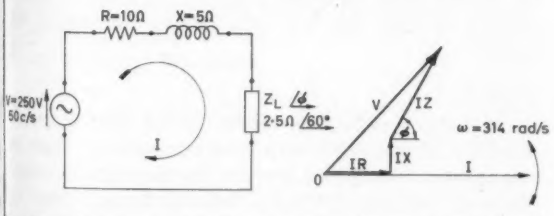
The text should contain a selection of well-chosen worked numerical examples to illustrate the application and use of the principles, as these principles and concepts are developed. In addition, there should be sets of carefully selected exercises (with answers provided at the end of each question) to be worked by the reader. There is also much justification for providing questions on which the student would write essays, the preparation of which would clarify and consolidate the subject.

Fundamentals

The material comprising the text should concentrate on an accurate formulation of the physical principles of the subject, with avoidance of undue descriptive matter more appropriate to a postgraduate or user treatment. All material not essential to an understanding of the subject, or to its appreciation, should be ruthlessly eliminated. In particular, attention should be paid to the physical considerations underlying each topic, without confusing the issue with non-essential mathematics.

All lecturers know of the advanced student who has only a hazy knowledge of fundamental principles. This deficiency can, in many cases, be attributed to a premature introduction of mathematical techniques without previously establishing a clear and sound picture of the physical principles on which the mathematical techniques are based. A clear appreciation of physical principles is especially desirable where the nature of the problem is such that the application of mathematical processes is only possible with drastic simplification. Such simplification may be misleading and a disservice to the student.

On the other hand, a subject should be given an analytical treatment where this is appropriate, but the analysis must be based on sound physical principles, with the assumptions and simplifications clearly stated. The analytical methods used must not, however, be beyond the intellectual attainment of the average undergraduate.



Complementary circuit and vector diagrams with stated standard conventions

Validity

The text should provide a clear indication and examination of the limits within which the data of the technological problems are known, and should examine the extent of the errors arising from lack of purity of the circuit components.

Most subjects in electrical engineering are developed on certain assumptions, such as that linear analysis is applicable and the use of sinusoidal supply voltages. These assumptions often give wrong impressions, and few students realize the severe limitations of linear analysis.

An introduction to graphical and diagrammatic methods, even where analytical methods are applicable, is desirable for all undergraduate students, and the useful generality of these methods should be stressed. A critical comparison of graphical or diagrammatic and analytical methods used in the solution of engineering problems should be an essential feature of any undergraduate textbook.

Owing to the inevitable assumptions, approximations and limitations involved, an appraisal of the validity and practical use of any result obtained by mathematical reasoning is essential in studying an engineering problem. The result, to an engineer, is far more important than the methods by which it is derived. Stress should be laid on the formulation of the problem and the interpretation of the analytical results.

The actual solution, especially where standard mathematical processes are involved, should merely be quoted, and the student left to confirm the result as an exercise, the necessary experience having been acquired in his mathematical studies. It is, for instance, undesirable and educationally disastrous to introduce the solution of simple transient problems with the aid of the Laplace transform. Advanced analytical techniques should follow

the acquisition of a thorough understanding of a subject.

All too many undergraduate textbooks repeat errors made by earlier authors; some even add to these errors. Mistakes made involve fundamental concepts as well as content transfer.

Format

The general format and printing must be attractive and conducive to easy reading. The reader is assisted by a good index and the inclusion of reasonable cross-references. Some readers, however, dislike cross-references as being a disturbance to thought and consider that a good index eliminates the need for cross-references. References for further reading are essential and encourage a critical and inquisitive outlook in the reader by comparing the views of a number of authors.

Summary

It is believed that many inferior textbooks published at the present time could have been improved if attention had been given to the principles suggested in these notes. An intending author can gain much by invoking the assistance of his colleagues. This help can take a number of useful forms, such as discussion of difficult or obscure points, suggestions for possible improvements, the elimination of unnecessary material and errors, and assistance with the tedious task of proof-reading.

When in doubt, a publisher usually obtains advice; but it is suggested that all publishers would benefit by having each manuscript critically read by at least one authority, anonymous as far as the author is concerned. The cost of this would be fully justified, even in the case of the best manuscript.

MEETING OF THE INSTITUTION COUNCIL, 3rd NOVEMBER 1960

THE following summary of reports received and decisions reached by the Council of The Institution at their meeting on the 3rd November 1960 is issued on the authority of the President in a form approved by the Council. It will be understood that this report does not purport to be a complete account of the matters discussed at the meeting, as some items are to be the subject of further discussion by the Council.

Membership

The Council gave final confirmation of the election of those candidates whose names had been published with the September 1960 *Journal*, to become effective from the 1st November 1960. Taking these into account, the total membership at that date was 46573.

Institution Library

The Council accepted a recommendation of the General Purposes Committee that smoking should be permitted in the Library of The Institution at Savoy Place for a trial period. Smoking would be confined in the first instance to a suitably furnished central area in the Library.

Ordinary National Diploma in Engineering

On the recommendation of the Examinations Committee, the Council approved the conditions of award of an Ordinary National Diploma in engineering which had resulted from discussions between members of the Joint Committee for National Certificates and Diplomas in electrical engineering (England and Wales) and the corresponding committee in mechanical engineering. Existing courses leading to an Ordinary National Diploma in either electrical or mechanical engineering would be replaced by the new award, subject to the agreement of the Council of The Institution of Mechanical Engineers, who had also been asked to approve the proposal.

Binding the *Proceedings* and the *Journal*

The Papers Committee wished to introduce a change in the method of binding the *Proceedings* and *Journal* of The Institution. They had examined a proposal that *Proceedings* papers should be published only as 'separates' but had come to the conclusion that this would be impracticable owing to the disproportionate amount of labour and expenditure involved in applying this procedure to the increasingly large quantity of technical material issued by The Institution. It had seemed to the Committee that what was really needed was a method of binding the issues of the *Proceedings* which would enable a member to extract for filing any paper in which he was interested. Various methods of removing a paper from an issue of the *Proceedings* without disturbing the other pages had been considered, and it appeared that 'perfect' binding would best meet these requirements.

In 'perfect' binding, each leaf is guillotined on all four edges, the leaves are all clamped together, the spine is slightly roughened, and an ester-plasticized polyvinyl acetate emulsion is applied. The re-binding of the annual volume does not present any difficulty; it can be either 'perfect' or sewn.

In the estimate of the printer, the cost would be no greater than that of the present method. The Council approved this proposal (see p. 708).

Joint Committee on the Applications of Electricity in Aircraft

It was reported that a Joint Meeting had been arranged with the Royal Aeronautical Society to be held on Friday, 11th November 1960, at which Lord Caldecote, D.S.C., M.A., ASSOCIATE MEMBER, would deliver a lecture on 'The future of "electrics" and "electronics" in aircraft and guided missiles', its purpose being to launch a scheme of Joint Discussion Groups between the two organizations throughout the country.

EUSEC

The Council received a report on the Seventh Plenary Assembly of the Conference of Representatives from the Engineering Societies of Western Europe and the United States of America (EUSEC), held in Brussels from the 29th August to 3rd September 1960. The recommendations of the Conference made at this assembly were referred to

the interested Committees of the Council for consideration and report on recommended action, since these required ratification by each constituent society.

One recommendation related to the preparation of a brochure describing the constitution and activities of EUSEC and its member-societies. The cost of the brochure would be defrayed by the member-societies in proportion to their membership, and each society would be entitled to a proportional allocation of copies of this edition; The Institution would receive 250 copies, and its estimated share of the cost was about £60.

Gift

It was reported that Mrs. E. Young, daughter of the late Sir John Aspinall, who had been President of The Institutions of Civil and Mechanical Engineers and chief engineer of the Lancashire and Yorkshire Railway when this had been electrified, wished to present to The Institution a silver model of a driver's control handle which had been given to her father at the opening of the Liverpool–Southport electrified line. The Council agreed with pleasure to accept this gift and directed that a suitable letter of thanks be sent to Mrs. Young.

C.E.E. MEETING IN LONDON

The International Commission on Rules for the Approval of Electrical Equipment (C.E.E.) met in London from the 12th to 23rd September 1960, and 120 delegates from 15 member-countries attended. The chair was taken at meetings by the C.E.E.'s President, Prof. J. C. van Staveren. Work was undertaken at the plenary meeting and at meetings of the technical committees.

Identification of earthing core of flexible cables

At the plenary meeting, the use of a combination of green-yellow for the identification of the earthing conductor was considered, and all countries except France agreed that this colour combination should never be used except for earthing or protective purposes.

Several countries (including the United Kingdom) made reservations on the proposals to prohibit the use of the single colours green, yellow, red or grey in association with the green-yellow earthing core for the other cores of flexible cords and cables. Subject to these reservations, the resolution was unanimously agreed (the United Kingdom abstaining from voting), and it was decided to submit the resolution to the I.E.C. for consideration.

It was decided (the United Kingdom again abstaining from voting) that the preferred colours for a 3-core flexible cable shall be green-yellow, blue and black.

Colour code for fixed wiring

A proposal to draw up a colour code for the identification of the conductors in fixed wiring was opposed by the United Kingdom and a number of other countries because it was considered better to leave this for the attention of those responsible for the wiring regulations of individual countries. It was finally decided to refer the matter to the technical committee dealing with cables.

Mains-operated radio-receiving apparatus

A draft of a new edition of I.E.C. Publication 65 'Safety requirements for electric-mains-operated radio-receiving apparatus', which had replaced C.E.E. Publication 1, had been circulated. It was agreed that it would be useful if the standard C.E.E. classification for protection against electric shock, intended primarily for domestic equipment used by unskilled persons, were introduced into the safety rules for radio and television receivers.

Switches, plugs and sockets

The meeting of the appropriate technical committee discussed amendments to C.E.E. Publication 7 'Plugs and socket-outlets for domestic and similar purposes'. In view of the great differences between the British and Continental specifications for plugs and sockets, British specifications were not considered.

The meeting discussed a draft standard sheet for a two-pin plug for connecting appliances protected by suitable insulation. It was decided that a new draft for switches for appliances should be circulated for consideration in 1961.

Cables

The meeting considered amendments to the C.E.E. specification for rubber- and p.v.c.-insulated cables and cords. Changes in the construction of cables were given in the amendments approved by the plenary meeting.

Proposals of a working party on the standardization of the conductors of non-flexible cables were considered. These were agreed with minor modifications, and all countries were asked to state at the next plenary meeting in May 1961 when they would be willing to bring them into effect in their national specifications. British representatives said that the changes involved were so great that it was not possible to say at present whether, or when, the proposed C.E.E. standard could be adopted in British Standards for cables.

The dimensions of flexible cables were provisionally agreed, subject to a number of amendments.

Lighting fittings

The reading of the fifth draft specification for incandescent-lamp lighting fittings was almost completed, but it was decided that a further draft should be prepared for final review by the technical committee.

Detailed British proposals for heating-test methods were adopted. A working party was formed to revise the clauses on heating and the limits of permissible temperature rise.

RAPID METHODS OF TESTING FOR WEAK RADIOACTIVITY

A short article based on a Measurement and Control Section paper (3258) entitled 'Rapid methods for ascertaining whether the activity of a weak radioactive sample exceeds a predetermined level' by E. H. Cooke-Yarborough, M.A., Member, and R. C. M. Barnes, B.Sc.(Eng.), Associate Member. The paper was published individually in July 1960 and will be republished in Part B of the Proceedings. It was read before the Measurement and Control Section at Savoy Place on the 25th October 1960 (see p. 748). The authors are in the Electronics Division of the U.K.A.E.A. Atomic Energy Research Establishment.*

A RADIOACTIVE substance contains atoms which are in an unstable state and can change at random to a more stable state with the emission of an energetic photon (γ-ray), a nuclear particle, or both. The radioactivity of the substance can be measured by detecting and counting individually a known proportion of the emitted particles or photons. Because the detected events occur at random, the numbers counted in successive equal periods of time will not, in general, be identical, but will be distributed about some mean number N with a standard deviation which is approximately $\sqrt{N}$ expressed as a number, or $100/\sqrt{N}$ expressed as a percentage.

Thus, to reduce the statistical uncertainties in the measurement of radioactivity to an acceptably low level, counting must continue long enough to allow a sufficiently large number of events to be counted. When the radioactive source is a weak one, the time taken to accumulate sufficient counts may be inconveniently long, so when sources of differing activity are to be tested it is desirable to avoid counting individual samples for longer than is necessary to provide the desired statistical accuracy.

Counting procedures

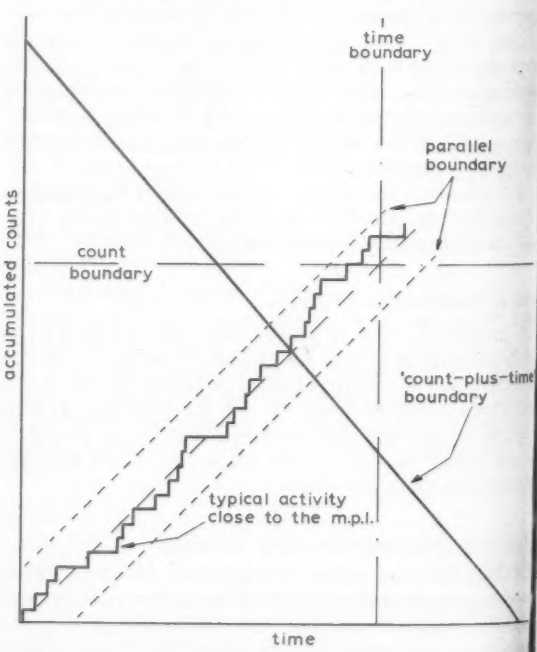
Several commonly-used counting procedures are illustrated in Fig. 1. A plot of counts registered against time takes the form of a 'staircase', in which the steps are of equal height but are randomly distributed on the horizontal scale. The most usual procedure is to count the number of events which are detected within a fixed time, counting being terminated when the plot of counts against time crosses the time-boundary represented by the vertical line of Fig. 1.

The average number of events counted is proportional to the mean rate at which they are registered, so the statistical accuracy of the measurement is proportional to the square root of the strength of the activity. Samples having relatively high activities may be measured to an unnecessarily high degree of statistical accuracy, which is wasteful of time.

An alternative procedure, which allows the counting to continue until a predetermined number of events has been registered, is illustrated by the horizontal boundary line of Fig. 1. Here all samples are measured with the same statistical accuracy, irrespective of their activity, and much time may be spent in counting weak samples. This again is time-wasting if the activity of weak samples is of less interest than that of stronger samples, as is frequently the case.

A compromise between these two procedures is to add, to the number of events registered, a number proportional to the elapsed time, and to measure the time taken for this total to reach a predetermined number. This is illustrated in Fig. 1 by the boundary line which slopes down from left to right.

Often it is not necessary to obtain a quantitative measure of the radioactivity but merely to test, to a given degree of statistical accuracy, whether the activity exceeds a given maximum permitted level. A widely-used test is to impose both count and time boundaries (corresponding to the horizontal and vertical lines of Fig. 1). This will be referred to as the rectangular-boundary test. The boundaries are so chosen that, when the activity is exactly at the maximum permitted level, both are equally likely to be reached first. If the activity is higher than this, the counting period will usually end at the count boundary, giving an 'above' decision, whereas if the activity is less the count will usually end at the time boundary, which gives a 'below' decision.

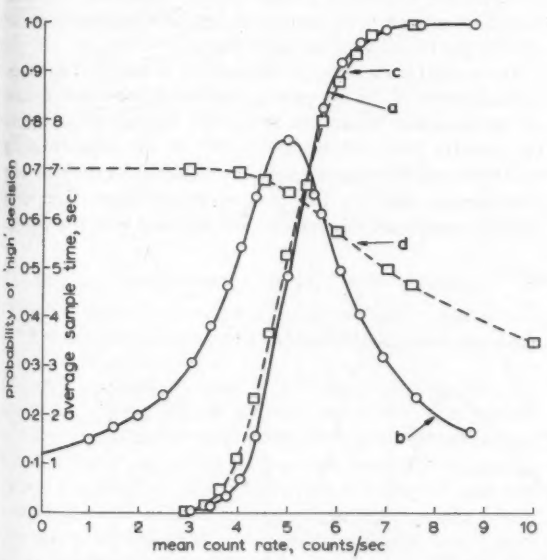


1 *Four different counting procedures*

* This article and those following are based on, and written by the authors of, current Institution papers. The authors have been asked to make these articles, so far as possible, interesting and of appeal to electrical engineers who have no specialized knowledge of the topics, and the content of the articles is not necessarily confined to the subject-matter of the original papers

This procedure disposes of highly active samples relatively quickly, but all samples giving a 'below' decision are counted for the maximum time. For samples whose activity is well below the maximum permitted level, this takes an unnecessarily long time; for an observer watching the accumulation of counts can easily see, long before the full counting time has elapsed, that there is no prospect of the count boundary being reached before the time boundary. This is because, if the activity of the sample is well below the maximum permitted level, then even a statistically very imprecise measurement is enough to show this to be the case, with little chance of error.

A more efficient procedure which exploits this possibility is indicated by the two parallel sloping boundary lines of Fig. 1. Counting is terminated if the cumulative plot of counts against time crosses either of these boundary lines. If the events are detected at a rate corresponding closely to the slope of these lines, many will be counted before a decision is reached. At rates which are higher or lower, the upper or lower boundary is crossed earlier and the appropriate decision is reached correspondingly sooner. The statistical reliability of the decision increases with the separation between the two boundaries.



2 *Operating-characteristic and average-sample-time functions for parallel- and rectangular-boundary sequential tests of similar discriminating power*

○ parallel boundaries
a o.c. function
b a.s.t. function
□ rectangular boundaries
c o.c. function
d a.s.t. function

Operating characteristic

These two qualitative tests have been studied on a digital computer using a Monte Carlo process to simulate the random occurrence of radioactive events. The essential feature of qualitative tests of this type is the operating characteristic, which relates the strength of the radioactive source to the probability of obtaining a 'high' decision.

Fig. 2 shows the operating characteristic (o.c.) of a rectangular-boundary test in current use in automatic monitors for α-particle radioactivity on the hands, together with the operating characteristic of a parallel-boundary test designed to give a comparable probability of error. (For the cases studied, the maximum permitted level was taken as 5 counts/sec.) The average sample time (i.e. the average time to reach a decision on an individual sample) is also plotted for the two types of test.

It will be seen that the average sample time for the parallel-boundary test exceeds that for the rectangular-boundary test only when the radioactivity is close to the maximum permitted level. When the activity is far below the maximum permitted level (as, it is to be hoped, will usually be the case), the parallel-boundary test has a decisive time advantage.

Table 1. Comparison between average times taken by rectangular-boundary and parallel-boundary tests

	average time for rectangular-boundary test	average time for equivalent parallel-boundary test
	sec	sec
(a) maximum permitted level 5 counts/sec (no background activity): activity uniformly distributed between zero and 10 counts/sec	5·9	3·35
(b) as (a), but 90% of samples inactive: remainder uniformly distributed between zero and 10 counts/sec	6·9	1·41
(c) maximum permitted level 5 counts/sec superimposed on 20 counts/sec background: activity uniformly distributed between background and background plus 10 counts/sec	33·4	16·7
(d) as (c), but 90% of samples inactive (background only). Remainder uniformly distributed between background and background plus 10 counts/sec	34·8	7·08
(e) as (b), but discriminating power increased fivefold	172	8·04

These two procedures are further compared in Table 1. Line (a) compares the average sample times for the case where the activities of the various samples tested are uniformly distributed between zero and twice the maximum permitted level. Line (b) illustrates the more realistic situation where only 10% of the samples have activities distributed in this way, the remainder being nearly inactive. Here the parallel-boundary test shows to still better advantage.

Lines (c) and (d) show that, when the activity to be measured is superimposed on a steady background activity, the advantage of the parallel-boundary test is maintained and the actual saving of time is considerably increased.

In tests designed to discriminate between high and low activities more accurately than in Fig. 2, the parallel-boundary test has a still greater advantage over the rectangular-boundary test, as indicated in line (e) of the Table.

The parallel-boundary test can, in individual cases, proceed

for a very long time before either boundary is crossed. This can be prevented by imposing, in addition, an over-all time limit. It can be shown that a suitably chosen time limit has very little effect on the operating characteristic.

Another variant is to dispense with the upper limit of the parallel-boundary test and use the lower in conjunction with one of the other limits shown in Fig. 1, for example the time limit. If most samples are below the maximum permitted level, the average sample time will be only slightly increased, but a direct measure is obtained of the activity of all samples which are above the maximum permitted level.

Radioactive materials are becoming ever more widely used. As a result, much time is spent in testing for small amounts of radioactive contamination. Use of the procedure described above can bring about a substantial reduction in this time, without reducing reliability. 621.317.1 : 621.374.32.001.4

A.C. OPERATION OF ION CHAMBERS AT HIGH FLUXES

A brief article based on a Measurement and Control Section paper (3207) with the above title by J. Watson, B.Sc., S.M., Ph.D., Graduate. The paper was published in the Proceedings (Vol. 107, Part B, p. 216). The author is with Ericsson Telephones Ltd.

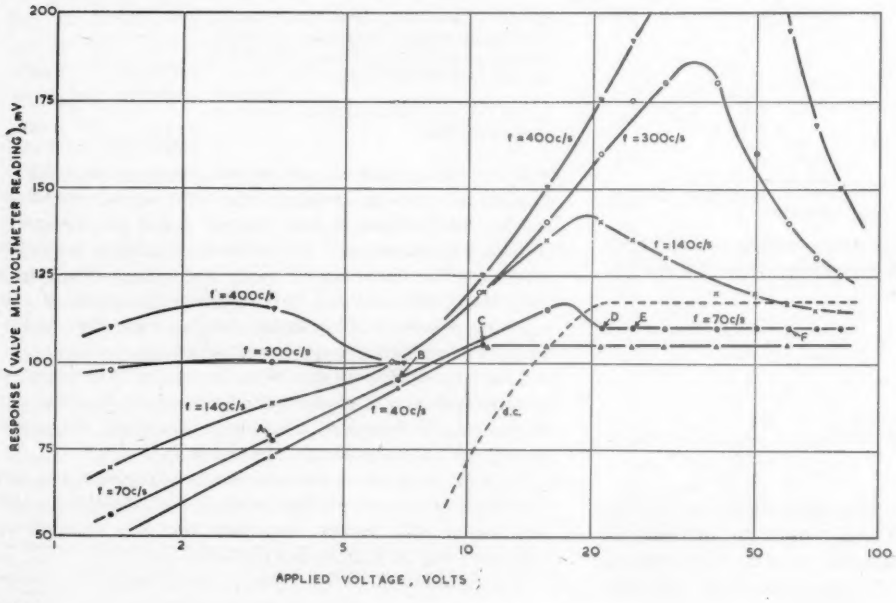
In a nuclear reactor, the power produced is proportional to the neutron flux generated. Because of this, the measurement and control circuits for reactors working at high fluxes have been designed to operate from the small direct currents obtained from neutron-sensitive ion chambers. The purpose of the paper is to show that such an ion chamber can be successfully operated using an alternating polarizing voltage —a technique which has the advantages of making unnecessary the provision of stabilized d.c. amplifiers, and of providing a transducer network which may eventually be incorporated directly into an a.c. servo system for purposes of power control.

Two components of current

When an alternating polarizing voltage is applied to an irradiated ion chamber, two components of current appear. First, a purely capacitive quadrature current flows. This varies only with applied voltage and frequency, and may be backed off using an anti-phase supply and a suitable capacitor. Otherwise, the backing-off current may be injected by coupling the anti-phase supply to the third electrode of a gamma-compensated chamber, though here a trimming capacitor would be needed. The unwanted capacitive component can also be put to use as a 'fail safe' signal.

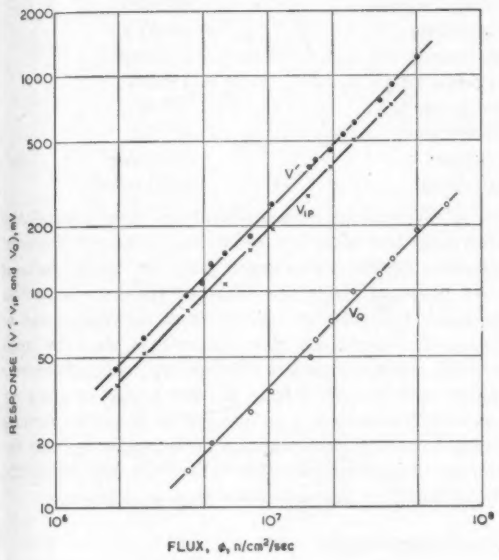
The second component of the current is due to the motion and collection of the ion pairs generated in the active volume of the chamber. When the sinusoidal voltage cycle begins, the positive ions will begin to drift to the negative-going electrode, and the negative ions (or electrons in the case of a free-electron gas) to the positive-going plate. The drift velocity, and hence the current, will increase with the voltage

1 *Variation of response with applied voltage for RC1 chamber in Gleep*
hydrogen filling at 150 cm Hg $\phi = 4{\cdot}9 \times 10^6$ n/cm²/sec

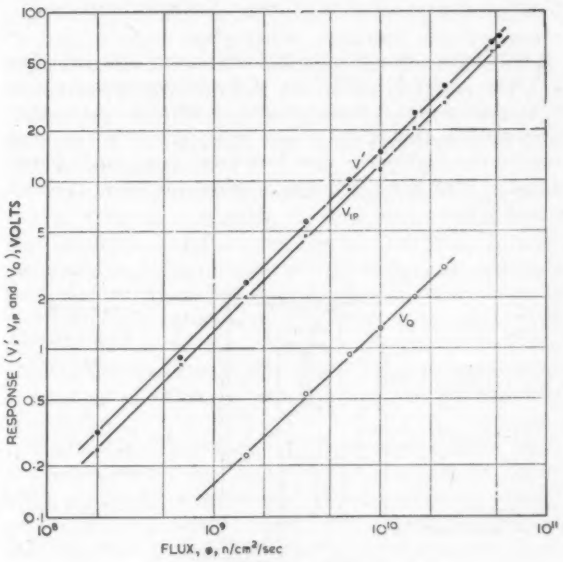


until the rate of collection is equal to the rate of generation of ions, when the current will become constant. Any further increase in voltage will now serve merely to reduce the ion concentration in the active volume.

When the voltage falls below saturation level at the end of a half-cycle, the ion current will fall and the concentration will increase rapidly. When the voltage reverses, therefore, a large number of ions will be present in the active volume, and their movement (now in the opposite direction) will constitute a peak in the current waveform. This current waveform may therefore be expected to have an initial peak followed by a saturation plateau for each type of charge carrier. Furthermore, if the filling is a free-electron gas such as hydrogen, the initial transient due to the electrons will be over before the heavy ion peak has formed, owing to the much higher mobilities involved.



a



b

2 *Response/flux-level characteristic for RC1 chamber*

a chamber filled with hydrogen at 150 cm Hg and irradiated in Gleep
b chamber filled with hydrogen at 15 cm Hg and irradiated in Bepo

Definition of a.c. saturation

Waveforms for both free-electron and electronegative gases are given in the paper, the former showing the initial electron 'spike' which precedes the heavy ion waveform.

The existence of such a waveform provides a definition of 'a.c. saturation', namely a condition such that all ion pairs formed during any half-cycle are collected by the electrodes before the end of the next. A departure from this condition, due to a low voltage or a high frequency, would mean either that the drift velocity of the ions would be too low to permit complete collection, or that the half-period would be too short. This means that the ion density would rise until limited by recombination and diffusion processes, and the chamber current would also rise, since it is proportional to this ion density.

Fig. 1 shows how a plateau of ion (here called response) current occurs when the applied voltage and frequency are correct, and indicates that, as expected, the higher the frequency, the higher must be the voltage to ensure saturation. At saturation, the variation of response with frequency is only 0·033% per cycle.

Fig. 2 shows the excellent linearity of the response current with neutron-flux level for a saturated a.c.-operated ion chamber. This current was measured in terms of a non-sinusoidal voltage V' across a 1 megohm resistor as read by a valve voltmeter, and the in-phase and quadrature components of its fundamental were measured using a transfer-function analyser. If the chamber is operated in the unsaturated condition, the response current is much higher but does not vary linearly with flux level. The law followed is between the linear law as dictated by diffusion processes alone and the square law produced by recombination phenomena.

'Chopper' effect

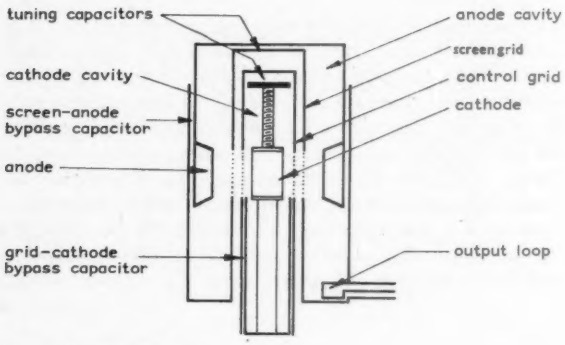
If a square wave of sufficient magnitude is applied, then, provided that the rise-time is fast enough to allow few ions to accumulate between reversals, the output current wave should also be square, thus providing an inherent 'chopper' effect suitable for feeding into an a.c. amplifier for subsequent demodulation. Here also, a backing-off condenser should prove unnecessary, since the initial rapid capacitive spike can be removed or ignored using other techniques.

621.387.422 : 621.317.79

Ultra-high-frequency tetrodes

This short article is based on a Graduate and Student Section paper with the above title by P. Powers, B.Sc., Student. The paper was read before the North-Eastern Graduate and Student Section at Newcastle upon Tyne on the 20th November and at Sunderland on the 26th November 1959, and it was awarded a premium by the Council. The author is in the Department of Electrical Engineering, King's College, Newcastle upon Tyne.

APART from a period in the late 1930's, very little work has been published on the use of the tetrode structure as a high-power source at frequencies up to 500 Mc/s. Nowadays, klystrons are almost universally used, but it is not until recently that high-power ones have been constructed—6 MW pulsed or 9 kW mean is typical of the higher-power range of present types.



1 *The resnatron*

This sort of output can easily be reached by tetrodes with very high efficiencies—of the order of 70%. Single-cavity klystrons always have an efficiency less than 50%, and multi-cavity designs rarely reach higher than this. The reason for this higher efficiency in the tetrode lies in the fact that the electron beam can be completely modulated. Powers of the order of 9 kW have been produced by tetrodes made during the 1939–45 War, and it would seem that if more research could be done they would prove active competitors to klystrons.

The resnatron

The first high-power u.h.f. tetrode to be constructed was the resnatron (Fig. 1). This is a cylindrical valve with the four electrodes concentrically mounted. Tuning is by resonant cavities, there being a cylindrical coaxial cavity between anode and screen and one between control grid and cathode. Standing waves are set up in these cavities during operation, and the electrodes are therefore set at the maximum voltage position, which is at the centre of the system for a half-wavelength cavity, although three-quarter-wavelength cavities are also used, as shown in Fig. 1.

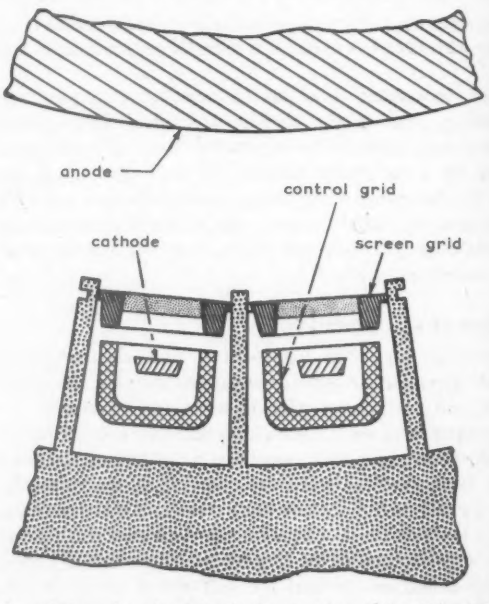
For various reasons, operation is in class C, and high potentials are used on the screen and anode to accelerate the electrons through the cathode cavity as quickly as possible. Vanes are usually fitted to the anode surface to serve as a secondary-emission trap, since it is not always possible to arrange for space-charge suppression of secondary electrons. Typical operating conditions are as follows:

operating frequency	400 Mc/s
anode voltage	15·5 kV
anode current	7·2 amp
input power (d.c.)	111 kW
output power (r.f.)	70 kW
anode efficiency	65·1%
grid current	1·15 amp
bias potential	1900 volts

One or two workers have modified the basic principles to produce reflex and axial-flow resnatrons. In the reflex version, the current collector is the 'screen grid', the 'anode' being at negative potential. Thus the electrons traverse the output cavity twice, lowering the loaded shunt impedance and so increasing the bandwidth. The screen grid must be made substantial, and consequently troubles are encountered from unwanted currents arising from the first transit of electrons. The axial-flow resnatron is an attempt to raise the operating frequency—here the electron beam flows axially through two quarter-wavelength cavities—but only fairly low efficiencies can be obtained on account of the large grid areas.

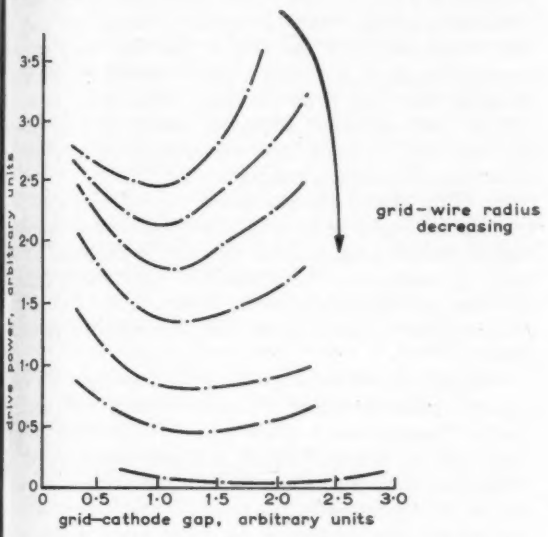
External-cavity tetrode

More recently, a tetrode has been produced in America using 40 'unit tetrodes' for ease of construction. This valve



2 *External-cavity tetrode showing two of the 40 'unit tetrodes' used in its construction*

has one or two interesting features. It will be seen (Fig. 2) that the cathode is mounted on the outer diameter and the unit tetrodes are fitted into a solid block of metal which forms the screen-grid connection. In this valve only the electrode system is in the vacuum envelope, external cavities being used. High power gains and outputs are quoted in the data, and it would seem that much research has gone into its construction.



3 *Grid drive power as a function of the grid–cathode gap for varying grid-wire radii*

In the design of tetrodes of this type, after deciding on class C operation the provision of sufficient emission is the next essential. Very large valves, e.g. of the resnatron type, have to be continuously pumped. This means that tungsten is the only suitable emitter, and because of its low emission density it is essential to provide large cathode areas. Long lengths of tungsten cannot be used, since the cavities must be excited at, or close to, the voltage maxima. Similarly, large-diameter valves cannot be used lest circumferential modes should be excited. A compromise has therefore to be made, although an ingenious device is to put the cathode on the outer diameter, as in the American valve.

Power gain

In order that electrode dissipation may be kept to a minimum, it is essential that the beam be properly focused, and, for this, electrode configuration, potentials and dimensions must all be taken into consideration. The power gain of the valve is of prime importance, and, to keep this high, the grid current must be very low. Paying attention to the details of the shape of the electrodes and fitting Pierce cathodes both help in this respect.

To maintain a low drive power, the driving voltage must also be as small as possible, i.e. low cut-off voltages and high amplification factors are desirable and these, in turn, involve between them the inter-electrode distances, electrode potentials and dimensions. Also, it can be shown theoretically that a minimum occurs in the grid drive power, with a fixed grid-wire radius, for a certain value of grid–cathode gap (Fig. 3). Consequently, a compromise has again to be made, and the use to which the valve will finally be put may help in resolving it.

At ultra-high frequencies, several undesirable effects occur as a consequence of the time of transit of the electrons, among which are the introduction of a phase delay between upward grid swing and downward anode swing, cathode back-heating and frequency modulation of an amplitude-modulated signal. Large screen potentials, large positive drive voltages and small inter-electrode distances help to reduce these effects, but adjustment of these parameters must be made only in the light of their effect on the operation of the valve as a whole.

If a suitable solution can be found to all these interrelated problems, it will be possible to construct a tetrode with a large power gain, a high efficiency and a substantial power output at ultra-high frequencies. 621.385.4.029.6

Railway signalling

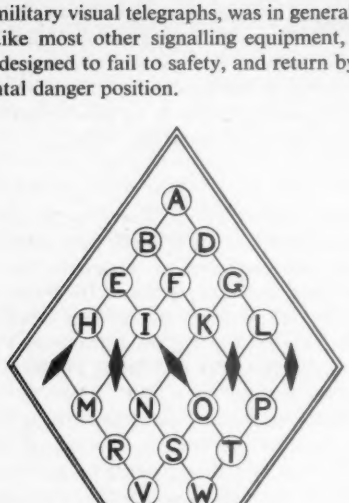
A short review of a Graduate and Student Section paper with the above title by M. H. Walshaw, B.Sc.(Eng.), Graduate. The paper was read before the Mersey and North Wales Graduate and Student Section at Chester on the 17th February and at Liverpool on the 9th March 1959 and was awarded a premium by the Council. The author is at the Royal Aircraft Establishment.

A RAILWAY signalling system is necessary to inform drivers of the state of the track ahead, and thus to conduct the traffic smoothly, efficiently and safely. With the growth in speed and traffic density, signalling methods in this country have developed from the simplest beginnings, and electricity has been employed at an ever-increasing rate for the past 120 years.

At first, 'policemen' regulated the traffic on the time-interval system, but were unable to prevent collisions between stations. It was realized that an interval of space, not time, must be kept between successive trains, and the development of the electric telegraph made the space-interval system, or block system, possible. The first successful railway telegraph was Cooke and Wheatstone's 5-needle speaking telegraph, installed between Euston and Camden in 1837 (Fig. 1).

Early signals were characterized by their great variety, but by the 1870's the semaphore signal, based on the type used in

naval and military visual telegraphs, was in general use on the railways. Like most other signalling equipment, semaphore signals are designed to fail to safety, and return by gravity to the horizontal danger position.



1 *The Cooke and Wheatstone 5-needle speaking-telegraph instrument*
Needles set to the letter E

The block system

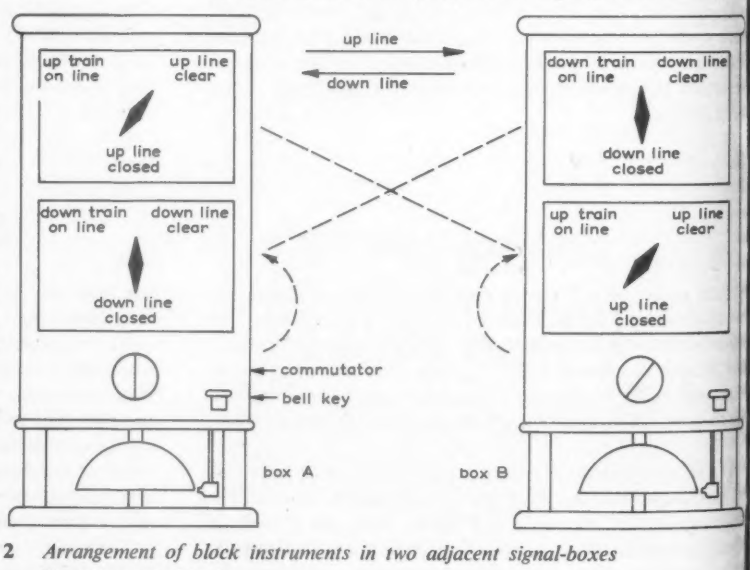
The block system has controlled the majority of our lines since about 1880, although the more densely loaded lines now use electric colour-light signalling systems. The object of the block system is to keep an interval of space between successive trains, and this is achieved by dividing the line into block sections, each controlled from a signal-box.

A signalman is not allowed to signal a train to enter the block section ahead until he has ascertained from his colleague in the box in advance that the section is clear. Special block telegraph instruments are provided to give a continuous visual indication of the state of each line in the block section.

Fig. 2 shows a pair of typical instruments in two adjacent signal-boxes, A and B. A has just offered an up train to B by means of a bell code, and B has accepted it by setting the two co-acting up-line indicators to 'up-line clear' by means of his commutator.

The signals and points controlled from each signal-box are interlocked mechanically to prevent the signalling of conflicting routes, and to prevent the clearing of signals unless the points are correctly set.

On single lines, token systems are used to ensure that only one train can be on the line. Each driver must be in possession of a token, in the form of a metal staff, key or circular tablet. These tokens are kept at each end of the line in special instruments, which are interlocked electrically so that only one token can be in use at a time.



2 *Arrangement of block instruments in two adjacent signal-boxes*
Up train accepted by B

Electrical devices in railway signalling

Perhaps the most important device is the track circuit used for the detection of vehicles on a given section of track. The rails of the section are isolated from each other, and an electrical supply is connected between them at one end. A relay connected across the rails at the other end is thus normally energized, but when a vehicle stands on the track its wheels and axles shunt the relay, which drops away to indicate 'track occupied'. Where an electric traction system is in operation, arrangements have to be made to avoid its interference with the track circuits.

Semaphore signals are now giving way to electric colour-light signals. These can show up to four different indications, and can be seen more easily at night and in fog than the oil lamps of semaphores. Installations of colour-light signals, controlled and interlocked by the track circuits, can handle a much higher density of traffic than the conventional block system.

Automatic train-control systems of various types are used to guard against the failure of a driver to observe his signals. London Transport use a system of train stops at each stop signal, but on British Railways a system which works in conjunction with the distant or warning signals is more suitable. An electromechanical system of this type has been used on the Western Region for many years, and a new inductive system is now being installed on the main lines of the other regions.

Modern electric installations

With the coming of colour-light signals and power-operated points, the large levers in signal-boxes can be

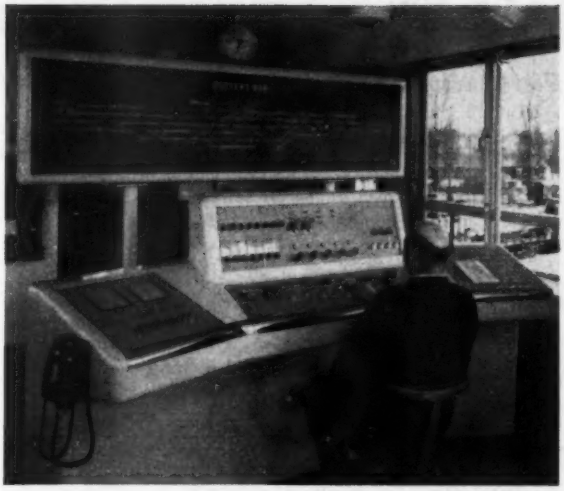
replaced by miniature levers, thumbswitches or pushbuttons. Miniature-lever installations, with electric interlocking between the levers, are now found at many main-line stations.

Thumbswitches or pushbuttons are used in route-relay interlocking systems, in which the interlocking is achieved by means of relays. A single movement by the signalman will set all the points for a particular route if the interlocking will allow it, and then clear the appropriate signal. The positions of all trains are shown by track-circuit lights on track diagrams, and in some cases the route switches are laid out in a geographical manner (Fig. 3).

Centralized traffic-control systems, in which the equipment at outlying stations can be remotely controlled from a central office over only two or three line-wires, have been in use for some time in America, Africa, Australia, etc. The first installations in this country are on the Styal line near Manchester and on the Sheerness branch in Kent, both recently electrified, and use a.c. coded-impulse and synchronous electronic-scanning devices respectively.

The railways of London Transport use automatic colour-light signals extensively, and terminal stations and junctions are now controlled by pushbutton panels or by programme machines. These machines use a punched plastic film to control the movements of the trains according to a predetermined schedule.

Railway signalling has come a long way from the days of the 'policeman' in his top-hat and swallow-tail coat, and there is no doubt that the future will see many interesting developments, especially in the application of new electrical techniques. 621.337.65



British Railways

3 *The console and illuminated diagram of the route-relay interlocking installation at Potters Bar, Eastern Region, British Railways*

Open-circuit noise in synchronous machines

A synopsis of a Supply Section paper (3340) with the above title by J. H. Walker, Ph.D., M.Sc., Member, and N. Kerruish, M.A., Associate Member. The paper is published this month in Part A of the Proceedings. The authors are with Associated Electrical Industries (Rugby) Ltd.

In order to predict the noise level of a synchronous machine, the authors develop equations to represent the permeance and m.m.f. variation at the stator bore. From these two equations, expressions are derived which give the force variation causing vibrations in the core. The method for calculating the amplitude of, and number of nodes associated with, any particular harmonic is given. From this, the loudness of the noise in decibels is obtained. Six examples are given of the application of the method to actual machines, on five of which the comparison is made between the results predicted by calculation and those obtained in service. Good agreement is obtained between calculation and observation, and it is thus possible to draw certain conclusions concerning the factors which influence the generation of open-circuit noise, in particular the objectionable noise at about slot frequency in synchronous machines. The paper shows that there are six such factors, namely:

Synopsis of paper

THIS is a synopsis of a paper published in the *Proceedings* which has not been read at an Institution meeting and which has not been reviewed in the *Journal*. It is included here primarily for reference. Reprints will be available in about two months

(i) The stator permeance harmonics caused by the presence of the stator slots

(ii) The rotor m.m.f. harmonics caused mainly by the shape and configuration of the rotor poles

(iii) The pole pitch of force harmonics

(iv) The frequency of the noise, which depends on the number of poles and the number of slots

(v) Peripheral velocity of the noise harmonic

(vi) Moment of inertia and natural frequency of the stator core.

For noise to be generated, factors (i) and (ii) must both be present in combination with one or more of the remaining factors. If required, the method can also be used to calculate the noise spectrum over a range of frequencies. It is shown that, theoretically, skewing of the stator or rotor may reduce or eliminate open-circuit noise in a machine, but that practical difficulties restrict its field of application. 621.313.32.016.36

PAPERS AND MONOGRAPHS

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PAPERS

Improvements in the precision measurement of capacitance
Paper 3159M, *Part B*

G. H. RAYNER, B.A., *and* L. H. FORD, M.SC.

ALL measurements of capacitance and resistance at the N.P.L. depend ultimately on the Campbell standard of mutual inductance and on frequency. Hitherto capacitance has been obtained from mutual inductance and resistance, using a Carey–Foster type of network. The precision obtained with this in the Astbury bridge has been considerably improved since it was constructed 20 years ago, and an accuracy of repetition of about five parts in 10^6 is now obtained.

Capacitance can also be derived from resistance and frequency: a Wien bridge has recently been constructed for this purpose. It has been designed to make a single precise measurement of capacitance (the repetition accuracy is two parts in 10^6) and thereby to complete a system of three measurements relating capacitance, resistance and mutual inductance in conjunction with frequency.

To be read on the 10th January 1961. This paper was originally published in the March 1960 Proceedings, Vol. 107B, p. 185

Some notes on the electrical requirements of general cargo docks
Paper 3365U, *Part A*

E. R. RADWAY

WITH special reference to the South Wales ports, the author outlines the functions of a general cargo dock and the effect of grouping such docks into a port system, his object being to stimulate thought and discussion on the improvement of electrical engineering in the dock industry.

He illustrates and comments on the electrical supply and distribution practices of the industry, the electrical features of the pumping plant used for hydraulic-power production and impounding services, the requirements for tenants and the safety of shipping, and some of the problems associated with the mechanical-handling plant.

Passenger reception and handling peculiar to the liner terminal ports, and the electrical installations of ships, are outside the scope of the paper.

Date of reading not yet fixed

Digital computers in power-system analysis *Paper* 3484S, *Part A*

P. P. GUPTA, PH.D., B.SC., *and* PROF. M. W. HUMPHREY DAVIES, M.SC.

THE authors have developed programmes for carrying out power-system load studies and transient-stability studies on an automatic electronic digital computer. The methods employed are similar to those used at present on network analysers, but improvements have been made where possible. In the solution of load studies, loads and generation are represented by equivalent admittances to neutral, and nodal voltage equations are used. A control programme which automatically adjusts the reactive-power generation and transformer taps to keep the voltages within satisfactory limits has been developed.

They have written a programme to carry out transient-stability calculations for a multi-machine system, using the standard step-by-step method, together with one to calculate the power-equation coefficients needed to compute the power transfer at the end of each interval. Significant generator characteristics such as saliency, flux decrement, voltage-regulator action, damping and governor action, which are normally neglected in network-analyser studies, have been included in the programme.

It is shown that computers can provide an efficient and economic tool for power-system analysis.

To be read on the 18th January 1961

MONOGRAPHS

Stability of a feedback system containing a limited-field-of-view error detector *Monograph* 420M

D. P. ATHERTON, B.ENG.

THE author examines a class of non-linear error-detector characteristics where, for large magnitudes of error, the error signal decreases with increased error. Sinusoidal and random-input analysis of a closed-loop system containing such a non-linearity is shown to necessitate the calculation of a family of describing-function curves to cover operation with a d.c. input signal to the non-linear error detector.

He discusses the peculiarities of such a non-linear system, and describes a simple method using a non-linear circuit to correct the adverse behaviour.

Limitations of distance-type protective equipment when applied to long extremely-high-voltage power lines *Monograph* 421S

A. WRIGHT, M.SC.

ON power lines, the currents which flow solely in the phase conductors travel near the velocity of light, whereas those which return through the ground and overhead earth wires travel more slowly, the speed depending on the line spacings, conductor size and nature of the ground. The author develops the full steady-state equations for a 3-phase line and examines a particular line to show the magnitude of this effect. The effect of transposing a line is also indicated.

Using the line equations, he studies the steady-state performance of basic distance protection fitted with compensating equipment to allow for the effects of the currents in the sound phases during earth faults. Large errors of measurement are found to occur in earth-fault conditions on long lines fed from small sources. The performance for faults which do not involve earth is satisfactory.

It is shown that non-transposition of a line makes the apparent impedance of a fault on a line depend on the source impedance

This causes further errors in the assessment of the positions of faults of all types.

The high transient time-constants on long lines increase the chance of mal-operation during the transient period.

The author concludes that distance protection may not be satisfactory on very long lines and that a study must be made of the complete power system before a decision can be made about its suitability for any particular application.

Interconnected-rotor induction motors *Monograph* 422U

N. C. ENSLIN, PH.D.

THE stators of two identical wound-rotor induction motors are connected to a common supply to produce fields revolving in the same direction. The shafts are coupled mechanically, and the rotor circuits are electrically connected together, with the voltages initially phased so that no rotor current flows. On rotating one stator relative to the other through an angle β, the rotor voltages are no longer in anti-phase, rotor currents flow and the unit produces torque.

Boucherot adopted a similar scheme in the construction of a composite machine with two stators and a common squirrel-cage rotor. The mid-points of the rotor bars were connected together through a resistive element so that currents always flowed in the rotor circuits and zero torque could not be obtained.

The author derives expressions for torque for the shunt-interconnected rotor developed by Boucherot and for the purely series-interconnected motor investigated by himself. He shows that, for the former, torque cannot be controlled from zero without voltage variation, whereas in the latter arrangement zero torque is always obtained when the phases of the induced rotor voltages are in opposition.

The properties and applications of the series-interconnected motor circuit are discussed. By the insertion of impedance, the torque/speed characteristics of the motors can be modified, retaining the zero-torque position. Possible applications include small hoists, cranes or lifts, and positioning, manipulating or tensioning drives for which precise control is required.

Frequency response of feedback relay amplifiers *Monograph* 423M

ZE'EV BONENN, B.SC.

THE author analyses the frequency response of feedback relay amplifiers by the dual-input describing-function method. At low signal frequencies, the amplifier behaves like a saturating linear amplifier. This picture is modified at higher frequencies, owing to synchronous effects, and it is difficult to achieve satisfactory operation when the ratio of the input-signal frequency to the periodic excitation frequency is appreciable. To eliminate synchronous effects within the signal band, restrictions must be imposed on the forward linear-transfer function. The theory is compared with an experimental example.

Sign matrices and realizability of conductance matrices *Monograph* 424E

PROF. G. BIORCI

GIVEN a conductance matrix G of order n, the problem of realizing it by a network with $n + 1$ nodes can be split in two parts: to find the tree of the ports corresponding to the given matrix G; and to determine the actual resistances of the branches of the network.

The author proposes a procedure to solve the first (topological) problem, which is simply concerned with the signs of the elements of the given matrix G. The successful development of the procedure can be considered as a necessary and sufficient condition for the existence of a tree corresponding to G.

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Discussion on **Field suppression of turbo-alternators** before the North-Eastern Centre

Discussion on **Generator/motor problems in pumped-storage installations** before the Northern Ireland Centre and a joint meeting of the South Midland Centre and Supply and Utilization Group

Discussion on **Characteristics and protection of semiconductor rectifiers** before the North-Western Utilization Group, the North-Eastern Centre, the Tees-Side Sub-Centre and the North Staffordshire Sub-Centre

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PART B. ELECTRONIC AND COMMUNICATION ENGINEERING (NOVEMBER 1960)

See the Journal for November 1960, p. 662

PART C. MONOGRAPHS (SEPTEMBER 1960)

See the Journal for September 1960, p. 561

POWER-SUPPLY DEVELOPMENTS

THE Central Electricity Generating Board, London, have received the consent of the Minister of Power to establish a 1400MW power station near to the existing 360MW station at Tilbury, Essex.

The first section of this new station, planned to be in operation by 1965, will consist of two 350MW turbo-generators, with two coal-fired boilers having an evaporative capacity of 2450000lb/h of steam.

Peak-load gas turbogenerator

The Board also intend to install a gas turbogenerator set, in which the prime mover has been developed from the 'Olympus' turbojet engine, at Hams Hall power station near Birmingham. The installation will be used to explore the applicability of this type of plant—based on aero-engine techniques—for peak-load and emergency operation.

Principal advantages of this kind of plant include low capital cost, light weight, suitability for operation under remote control, rapid starting and simple maintenance.

It is expected that the set will be commissioned in 1962.

OBITUARY

GEORGE LINTON HALL BROUGH

George Linton Hall Brough, C.B.E., B.SC., who was born on the 20th April 1890 at Kinross, died at Exmouth on the 13th September 1960. He was educated at Allan Glen's School, Glasgow, and studied electrical engineering at Glasgow University, receiving practical training with John Brown, Clydebank.

He joined W. G. Armstrong, Whitworth and Co., Newcastle upon Tyne, in 1913 as a draughtsman, and in 1914 was appointed assistant manager (electrical).

Joining the Admiralty at H.M. Dockyard, Devonport, in 1926, he later served in the overseeing service at Birmingham and at H.M. Dockyard, Hong Kong, before being appointed to the Directorate of the Electrical Engineering Department at the Admiralty, where he served as deputy director of electrical engineering until his retirement in 1951.

Of a modest disposition, his true worth quickly became apparent to those who had the good fortune to serve with him. During the period of pre-war rearmament he made great contributions to the shape of the wartime Navy, and, when the storm broke, his calm strength was in times of stress a great reassurance to his staff who, without exception, regarded him more as a friend than as a master. His advice was much sought and appreciated by the Royal Navy, in the Admiralty service, and in the shipbuilding industry. He was appointed a Commander of the Order of the British Empire in 1948.

He is survived by his widow and a married daughter.

He joined The Institution as an Associate Member in 1920 and was elected a Member in 1939. A.McL.M. J.C.T.

BERNARD HAGUE

Professor Bernard Hague, D.SC., PH.D., A.C.G.I., D.I.C., who died on the 29th September 1960, was born at Barnsley on the 7th July 1893. He received his early education in Yorkshire at Eccles Grammar School and at Rochdale Central Higher-Grade School. He was a millwright apprentice with Carter Bros., Rochdale, at 15 years of age, and later served with Ferranti, Hollinwood, attending Rochdale Technical College part-time. He gained an exhibition at the City and Guilds College, London, from which he graduated with first-class honours and later received the distinctions of M.Sc. and D.Sc. and a Fellowship.

Following experience at the Royal Aircraft Establishment, Farnborough, and at City and Guilds College, he joined in 1923 the University of Glasgow, in whose service he continued till his death, except for a year at Brooklyn Polytechnic Institute, New York, as visiting professor. On the retirement of Prof. G. W. O. Howe in 1946, he was the obvious successor to the James Watt Chair of Electrical Engineering in the university.

Many former students and colleagues will recall his ability for lucid presentation, which came from constant meticulous preparation and which was revealed particularly in his blackboard illustrations. His interest in all his students was personal and sincere, while his guidance in respect of their practical training will be recalled by many with gratitude. He was one of the founder-members of the Scottish Electrical Training Scheme and a member of its board of directors. To the affairs of the electrical profession he gave generously of his time and energies.

His major writings gave him among his peers an international renown—'Instrument transformers', 'Electromagnetic problems in electrical engineering' and 'Alternating-current bridge methods' being regarded as classics. The last mentioned is still regarded as one of the finest textbooks on the topic and has been translated into several languages, but all of them are characterized by the thoroughness and sincerity which stamped his work.

Every form of expression of the civilized human mind was a subject of study to him. He appreciated the visual arts and made his own contribution to them by his artistry and craftsmanship in wood and metal. Above all, his great love was music, and he was himself an oboist of great distinction. His wide humanitarian and intellectual interests made Prof. Hague known to and greatly respected by a very large number of people in all walks of life, for whom his death leaves the world the poorer in the things of grace and light. He was predeceased by his widow in January 1960 and is survived by a daughter.

He joined The Institution as an Associate Member in 1921 and was elected a Member in 1929. He served on the Scottish Centre Committee from 1940 to 1943 and in 1950–53; was a Member of Council from 1950 to 1953; and served on the Papers Committee from 1950 to 1953 and on the Examinations Committee from 1950 to his death. Five of his papers were published in the *Journal*, in 1917, 1922, 1923, 1924 and 1926. A.J.S.

PERCY WALTER TUCKER

Percy Walter Tucker who died at his home at Dorking on the 2nd October 1960 was born on the 9th December 1894. For 34 years he was a member of the editorial staff of the *Electrical Review*, for six years as technical editor.

He was a Kentish-man; he was educated at the Mathematical School, Rochester, and part-time at Gillingham Technical School and received his practical training in the Gillingham Corporation Electricity Department. From Gillingham he went in 1913 to Great Yarmouth, where he served in the municipal electricity department, becoming mains engineer, and studied for a year at Norwich Technical School. His career at Great Yarmouth was interrupted by the 1914–18 War, when he served with the 9th Scottish Division in France.

In 1925 he came to London as technical sub-editor of the *Electrical Review*, but it was later, between 1947 and 1953, that he became so well known in the electrical industry and beyond. As staff contributor he journeyed all over Great Britain, recording developments in electricity supply and the applications of electricity in industries of every kind. It is true to say that by his descriptions of industrial installations he made a valuable contribution to the spread of the use of electricity in industry.

When W. O. Fenwick died in 1953, Tucker was appointed to succeed him as technical editor. He held that position until December 1959, when he retired. For some time he had suffered bad health, but it was hoped that he would recover to enjoy many years of retirement. To the great sorrow of his colleagues, with whom he always had the most cordial relations, he lived but a few months after leaving. He is survived by his widow and a daughter.

He joined The Institution as an Associate Member in 1931 and was elected a Member in 1948. J.H.C.

ROLAND WHEELER

Roland Wheeler, O.B.E., who was born on the 1st January 1881, died on the 25th September 1960. He was educated at St. Edmund's School, Canterbury, and apprenticed to Southport Corporation electricity works. In 1902 he joined Salford Corporation as assistant mains superintendent.

In 1906 he was appointed chief assistant electrical engineer to the then Sanitary Commissioners of Gibraltar (predecessors to the City Council of Gibraltar) from a list of 109 applicants, and was promoted to chief electrical engineer in 1910. He was responsible for progressive reforms with the Gibraltar electricity undertaking by way of gas and steam reciprocating engines to turbine-driven plant, and in 1936 initiated the scheme of conversion of all steam- to Diesel-driven plant at King's Bastion power station. During his 35 years of service he was on several occasions commended for his initiative and shrewd qualities as an engineer and administrator. In 1935 he was appointed an Officer of the Order of the British Empire for services rendered to the community as city electrical engineer.

His retirement in 1941, when aged 60, was accelerated because of war exigencies in the fortress, and the City Council placed on record their high and sincere appreciation of the faithful and exemplary service he had rendered to the city and fortress of Gibraltar during a period of 35 years, praising him for his tact, personality and administrative ability.

He was a most charming and friendly person, popular with a wide circle of friends and acquaintances. He was a devoted family man and a keen sportsman, with tennis and yachting as his chosen sports. He attained outstanding prominence in local yachting, winning numerous trophies, and was rear-commodore of the Royal Gibraltar Yacht Club during the years 1927 to 1933 and vice-commodore in 1934.

He is survived by his widow and a son.

He joined The Institution as an Associate Member in 1910 and was elected a Member in 1924. E.V.A.

SOME RECENT BOOKS

INTRODUCTION TO LAPLACE TRANSFORMS FOR RADIO AND ELECTRONIC ENGINEERS

W. D. DAY

NEW YORK: INTERSCIENCE. LONDON: ILIFFE. 1960. 183 PP. 32S. 6D.

THIS provides a non-rigorous introduction to the Laplace transform, suitable for those who have reached the H.N.C. level in mathematics.

The earlier sections contain a sufficiently complete presentation of elementary transform theory for some facility to be gained in the use of transforms, while in later chapters more difficult theory is considered, the main object being to stimulate the reader to study more advanced texts.

The Laplace transform is introduced by way of second-order differential equations; the transforms of elementary functions are derived, and the corresponding inverse transforms are obtained using the method of partial fractions. Other topics include the common properties of transforms, the transforms of periodic functions, the unit-step and the unit-impulse functions and their transforms.

In the more advanced section of the book, work on the complex variable leads to the residue theorem, which is applied to the evaluation of inverse transforms. The convolution integral and its application to inverse transforms are considered, and Laplace transforms are used to solve simple partial differential equations.

Throughout, the theory is applied to suitable circuit problems, but the number of examples given for solution is not large—more should have been provided. However, the volume will certainly be of value to the qualified engineer or advanced student interested in acquiring the elements of Laplace-transform theory.

F. H. JACKSON

BEAM AND WAVE ELECTRONICS IN MICROWAVE TUBES

R. G. E. HUTTER

NEW YORK: VAN NOSTRAND. 1960. 378 PP. £3 13S. 6D.

THIS work hopes to give both student and worker an understanding of the operating principles of microwave valves by presenting a selection of the results of modern space-charge wave theory.

A rather long introductory section of 72 pages summarizes electromagnetic fundamentals for normal fast-waveguides and leads into the main body of the text, which starts with Chapter 7, covering the propagation of slow waves in periodically loaded waveguides. The next five sections develop the ideas of electron beams through gaps, drift regions, and slow-waveguide structures. The phenomena of interaction of the beam waves with the circuit waves are nicely developed for the various classes of valve. Chapters 13 and 14 consider the power-conversion problems and extend the concepts of mode coupling which have been touched on in previous sections. A fairly short chapter on noise completes the volume.

The whole subject of microwave valves is an extremely difficult one, but undoubtedly the new ideas presented here will enable the student to get a little closer to understanding the problems. The book is very competently written, and the author has selected the material quite well in the sense that there is reasonable continuity and development of ideas. However, it is not very stimulating to read, and much patience is needed to pick out the important statements from the mass of information presented in a uniformly dull style.

The production and lay-out are good, and the few mistakes that one expects in a first edition do not appreciably impair the readability.

DIGITAL COMPUTER PRINCIPLES

W. C. IRWIN

NEW YORK: VAN NOSTRAND. 1960. 321 PP. £2 11S.

THE author has been engaged in teaching the principles of computers to users, and his text is intended for beginners who may have had no previous acquaintance with computers, electronics or mathematics. It would be interesting to observe the reaction of the reader who is innocent of mathematics to de Morgan's rules, and those of the reader who knows no electronics to the transistor diagrams of Chapter 17.

Nevertheless, the volume is interesting and attractive and will help the less sophisticated to understand more-advanced works on computers, where they will find what Figs. 19–3 and 19–5 are meant to indicate, together with a comprehensible account of Fig. 41.

The book performs a real service in explaining the language developed for computer arithmetic, but the descriptions of hardware are too scanty to be of real value.

It is the sort of publication to borrow from a library for a week-end or two; its content is interesting and helpful.

A. T. STARR

BASIC PRINCIPLES OF NUCLEAR SCIENCE AND REACTORS

A. M. JACOBS, D. E. KLINE and F. J. REMICK

NEW YORK: VAN NOSTRAND. 1960. 262 PP. £2 9S.

THIS is essentially a textbook for undergraduates. The first three sections deal with atomic theory, binding energy and nuclear cross-sections. The next two are on fission and the chain reaction. Chapters 6 and 7 are on elementary reactor theory. Chapter 8 on reactor systems gives an account of the various reactors built or under development in the United States. The final sections are on shielding and on the utilization of radiation. A folding chart of the nuclides to a readable scale is given inside the cover, and there are problems for solution after every chapter.

This is a very readable work, with good print and

illustrations, written in clear language without obvious mistakes. It can be recommended as a student textbook, although demanding students will want something more. The most notable lacuna is the complete absence of any reference to the reactors built in Britain and the Soviet Union. B. L. GOODLET

DIRECT CONVERSION OF HEAT TO ELECTRICITY

J. KAYE and J. A. WELSH (*Editors*)

NEW YORK: JOHN WILEY. LONDON: CHAPMAN AND HALL. 1960. 356 PP. £3 10S.

'THE age-old dream of devising a box, with no moving parts, which converts heat directly into electricity, has become a reality in the laboratory.' This first sentence of the preface epitomizes the theme of an unusual kind of publication. In 1959 the Department of Mechanical Engineering at M.I.T. conducted a special summer programme on direct thermal/electrical conversion. The volume includes 23 of the papers by 30 authors.

Although the physical form is the book, the contents closely resemble those of a Convention issue of the Institution *Proceedings*. Rapid production (within much less than a year) accounts for some lack of cohesion and for an excess of repetition. It is only fair to quote the editors on this: they 'have not attempted to criticize the work of the contributors or to combine or reorganize the papers into one homogeneous story'.

When one examines the bases of the four main methods of conversion, one is struck by the fact that the working principles are old and well established. The novelty lies in their re-scrutiny in the light of new knowledge and their redevelopment with new materials.

Sections A and B deal with the thermoelectron convertor: in essence, the familiar diode valve using the kinetic energy of emitted electrons to reach an anode against a small negative potential. Section A deals with the vacuum and B with the gas-filled forms. The several papers range from discussions of experimental results and physical analyses to thermodynamic conversion principles and even the optimization of design.

Section C is concerned with the magnetohydrodynamic convertor, our old friend the Faraday disc with a stream of ionized gas replacing the spinning copper. The device could, one day, compete with the turbo-alternator in large-scale energy supply, for it is simple in principle and has a very satisfying efficiency.

Section D is about the thermoelectric convertor, a new development of the thermocouple with plasma or semiconductor junctions in order to reduce thermal loss. Finally, section E is a single chapter on the fuel cell.

Despite its somewhat unsatisfactory text-arrangement, the work is highly stimulating. The papers that it contains are significant and basic. M. G. SAY

COMPUTER ENGINEERING

S. A. LEBEDEV (*Editor*)

PERGAMON PRESS. 1960. 184 PP. £3 3S.

THIS is a collection of papers, largely unconnected except that all deal with some aspect of digital computation. The first one discusses the power supply system for the BESM computer. (Apparently the mains supply voltage may vary between +15% and −30% in a 24-hour period.) The next article, on digital integrating machines, takes up nearly half the volume. It deals only with serial, sequential machines using single or ternary increments, and magnetic-drum or accoustic-delay-line storage. This is followed by a fairly exhaustive study of dynamic flip-flops and their use in partially asynchronous operation; this paper may well stimulate further thought on this type of logic element.

The remaining pieces are all relatively short and include methods of monitoring a serial arithmetic unit and of rapid selection of words from a stored dictionary. Two articles (the only ones with common authorship) consider methods of overcoming the limitations of Russian ferrite cores in matrix storage units. The final paper gives transliterated Russian computer terms with their English equivalents and definitions.

The publication date in Russia is not mentioned, but there are no references later than 1956, and the first article refers to cathode-ray-tube storage in the BESM computer (BESM I was changed to ferrite-core storage some time before May 1959). This, coupled with the fact that the work nowhere acknowledges the existence of transistors, suggests that it does not give an up-to-date picture of Russian work on computers.

The book has been reproduced by photolithography, apparently from a typewritten text, and the quality of the few half-tone illustrations is poor. The publisher's notice attributes the high price mainly to the cost of translating, which appears to be much more expensive than original authorship. E. H. COOKE-YARBOROUGH

RADARGRAMMETRY

D. LEVINE

McGRAW-HILL. 1960. 330 PP. £4 13S.

RADARGRAMMETRY is defined in the preface as the science of obtaining reliable measurements by means of radar, and it is thus a subject of potential interest to many radar engineers. The emphasis in this volume is on the application of airborne radar to ground mapping, and the author develops, in considerable detail, the extent to which the errors present in targets on a p.p.i. radar display contribute to the internationally agreed mapping tolerances.

Approximately half the text is concerned with the geometrical problems of matching the p.p.i. presentation to an area on the ground, and to the various forms of map projection. The characteristics of a large number of map projections are described.

Probably the most interesting sections for radar engineers are those dealing with the elementary theory of radar returns and with aspects of the design of airborne radar equipments for mapping. In the former chapter, expressions are developed for the resolution of point and area targets, both in range and azimuth. The performance of plane and lens reflectors is examined, and a useful survey is made of investigations into those reflections from refractive inhomogeneities, insects and birds which are now considered to account for the presence of 'angels', or targets not readily identifiable on ground-radar p.p.i. displays.

The book is logically arranged and well printed and illustrated, but the inclusion of some photographic comparisons between actual radar displays and maps might assist the reader to visualize the effect of various types of error. It is likely to prove invaluable to those concerned in radar surveying, but will also be of great interest to radar system engineers dealing with ground surveillance, weather mapping and radar navigation.

J. C. FARMER

PLASMA PHYSICS

J. G. LINHART

AMSTERDAM: NORTH-HOLLAND. 1960. 278 PP. £2 10S.

SINCE 1956, when Kurchatov gave his famous Harwell lecture, the volume of publication of papers and conference reports on plasma behaviour has been very great. To name only a few of the major publications, there are Vols. 31 and 32 of the Proceedings of the United Nations conference held at Geneva in 1958, the Proceedings of the Uppsala conference of 1959, and four large volumes of Russian papers, edited by Leontovich. This material is in a pretty indigestible form, and it is specially necessary for a careful analysis to be made in which theory (which is very extensive) should be compared with simple experiments (which are few), so that future work can continue on a firm basis of experimental fact.

I was therefore delighted when I saw Linhart's book, as I hoped it would do just this. In fact, the title is very misleading because the text contains almost no physics at all. It describes first the motions of individual particles in electric and magnetic fields. Next, the collective theory, involving the forces due to charge displacement, is deduced, using the Boltzmann equation, and equilibrium states are discussed. Waves and instabilities, shock waves and collision, and relaxation processes are all the subjects of separate chapters.

The final sections deal with controlled thermonuclear reactors and other applications, e.g. direct conversion of heat to electrical energy and rocket propulsion. All these topics are discussed purely from the theoretical point of view, and no attempt whatsoever is made to correlate theory with experiment. It is often difficult to visualize the experimental situation which might be described by the theory.

This approach might be useful if plasma theoreticians were in complete agreement among themselves and the only requirement was to present the results in the most useful form. This is unhappily far from being the case, and my confidence in this work was finally undermined when I found no mention of the major controversies, which are still unresolved, on the theory of plasma oscillations.

A. H. W. BECK

ANALOGUE AND DIGITAL COMPUTERS

M. G. SAY, A. C. D. HALEY and W. E. SCOTT (*Editors*)

NEWNES. 1960. 308 PP. £2 10S.

THE 12 chapters in this volume are contributed by seven different authors; 6½ are concerned with digital computers and 3½ with analogue computers. The treatment is intended for newcomers to the subject of digital-computer design, including both students and those with experience in other branches of electronic engineering. There is no harm in treating both analogue and digital computers in the same book, though, as this book shows, there is from the engineering point of view remarkably little in common between them.

It might be doubted whether the ideal form for an introductory work to take is that of a symposium, but the editors have clearly been to some pains, and the publication contains a wealth of information clearly set out. The editors remark in the preface that the book has suffered delays in publication, and, while this is evident in a number of places, it does not seriously detract from its value as an introduction to general principles.

The information given is, on the whole, quite reliable, but two errors are worth pointing out. The explanation of why the ENIAC was so large, given on p. 147, is false, as is also the statement on p. 162 that B registers, in spite of their other advantages, do not decrease computation time. The 12 plates could have been used to much better advantage to illustrate the subject-matter. They show such things as a reel of punched-paper tape and a general view of a punched-card tabulator. Plate 1, which shows a picture of an abacus, seems particularly wasted.

M. V. WILKES

ELEKTRISCHE ANTRIEBE AUF SCHIFFEN—Vol. 5

SCIENTIFIC COMMITTEE OF VDE (*Editors*)

BERLIN: VDE-VERLAG 1960. 246 PP. DM28

THE book contains a series of separate papers describing various applications of electricity in ships; the papers were read at a joint meeting of the VDE (Association of German Electrical Engineers) and the German Shipbuilders Association.

Quoting various examples of modern construction, the first article reviews the use of electricity for the control and propulsion of ships and for driving such machines as pumps, winches, cranes and steering gear. The author stresses the need for protecting the electrical equipment against the adverse conditions of ship operation: splashing with salt water, frost, pitching and rolling, etc.

Other articles give detailed descriptions of modern electrical plants recently installed: on a dredger, a trawler, a cable-laying ship, a tanker, etc. Contactless regulation using magnetic amplifiers for 'sympathetic steering' is explained. The use of electronic computers for calculating the data of control systems is discussed, and consideration is given to electrical problems peculiar to naval applications, such as the increase in the wear of commutators and brushes.

The work may be recommended to ship designers as a guide to the selection of adequate electrical equipment to ensure an easy, safe, and smooth control of a ship and its activities.

A. KARLSBAD

YOUTH IN A TECHNICAL AGE

D. M. SILBERSTON

MAX PARRISH. 1959. 228 PP. 21S.

THE subtitle of Mrs. Silberston's book is 'A study of day release'.

The purpose of the author is to take, as a yardstick, the

Education Act of 1944, and to examine the ways in which Government and industry, and even the colleges themselves, have failed to achieve the ideals of the Act. The text, however, is not concerned only with a history of failures; it examines the different ways by which partners in part-time education have striven to overcome the obstacles of indifference, lack of amenities, lack of guidance from the Government between 1944 and 1956, and lack of resources.

There have been many achievements of various kinds—national apprenticeship agreements, the liberal attitude of individual firms, the imagination and enthusiasm of some colleges—but these are not enough. They are merely isolated activities in a field which has been woefully neglected.

Industry generally identifies day-release with vocational training. Mrs. Silberston challenges this view of continued education as being far too narrow. She sees the period between 16 and 18 as an opportunity for education in its widest sense which must be seized.

Her approach is based on sound common sense. She realizes that, in most cases, neither student nor industry will be satisfied with a programme that is not largely vocational, but she cites the emphasis placed on a liberal education in the C.A.T.'s and in Ministry of Education Circular No. 323 of 1957, and suggests that liberal education is more important than general education in the case of many boys and girls who switch, at 15, from the discipline of school to earning relatively high wages in a largely material society.

The author shows also that it is impossible to provide useful continuative education on a large scale if it is to be based only on the existing examination structure of National Certificate, City and Guilds, R.S.A. and similar courses, which are beyond the capabilities of many of those chiefly in need of continued education.

The best portion of the volume is that devoted to a description of part-time education as it is, and to arguments for a more liberal and more comprehensive system of part-time education. The author's suggestions for achieving this are perhaps less convincing. The statistical tables she offers are often not essential to her arguments, and the inclusion of a study of part-time education among young people in the British Post Office is interesting, but too much of a special case to be wholly relevant.

This work should be read by all who are concerned with day-release, and with special attention by those who consider that part-time education is already operating on the right lines.

H. L. HASLEGRAVE

AUTOMATIC CONTROL

The I.F.A.C. Congress, Moscow, 1960

THE first congress of the International Federation of Automatic Control was held in Moscow from the 27th June to 7th July 1960. Some 1100 delegates from 29 countries spent the first week in Moscow, at grips with the 280 papers submitted to the congress. The second week was devoted to visits to technical institutions and industrial undertakings in the environs of Leningrad, Kiev and Moscow.

Before the start of the formal proceedings, the committees of I.F.A.C. were convened; the United Kingdom was represented by Mr. J. F. Coales (leader of the British delegation) and Dr. J. H. Westcott. Grandiose schemes for the future of I.F.A.C. were sponsored by the Russian delegation, who were very willing to second people to these activities. Some other nations, not quite so heavily represented (such as the United Kingdom), foresaw difficulty, if this were accepted, in keeping their end up.

The congress was held in the Moscow University building and was launched by an impressive ceremony in the main assembly hall, followed by an undignified scramble to book for the technical visits and social events. The system here involved an unusually large number of bits of paper, each of which had to be correctly processed. It was rather reminiscent of our own wartime system.

The large number of technical papers were dealt with in parallel sessions, there being up to 11 occurring simultaneously at different levels in a 30-storey building. The business of organizing oneself to the right place at the right time became a major preoccupation, not assisted by the fact that many items were announced at the eleventh hour. However, an impression did percolate through from the sessions that the contributions to the conference had been at their best in matters pertaining to the theory of automatic control, had been well represented in the matter of components, but constituted rather a meagre showing in the applications of automatic control.

Theoretical papers

In the papers on theory, much interest was shown in the use of variational methods to improve control of complex industrial processes. The Russians, with their impressive background of contributions to the theory of non-linear mechanics, presented methods derived from work of Pontryagin founded on the classical dynamics of Hamilton–Jacobi partial-differential equations. This technique they term optimal control. The Americans, on the other hand, made very analogous contributions on the basis of multi-stage decision processes, as exemplified by Bellman with his dynamic programming techniques. One interesting paper (by a Russian, incidentally) sought to show that these two methods amounted to the same thing.

Perhaps not so directly related to the control problem were interesting papers on the stochastic methods, which emphasized the statistical analysis necessary with variational methods in calculating the probability-distribution signals

at various points in a system. The Fokker–Planck equations associated with the diffusion effects of Brownian motion made several appearances in this connection. A basic paper by Barrett indicated methods of analysing the behaviour of dynamical systems under the influence of random disturbances. Several other British contributions dealt with this particular aspect of theory.

The theme *par excellence* in the theory section, however, was undoubtedly that of adaptive systems. A surprisingly large number of papers had something to say about it. A wide variety of adaptive methods were discussed, but it was difficult at this stage to make any comparisons of efficiency between one suggestion and another. This is undoubtedly a subject we shall hear more about, although as yet very little has appeared in our own *Proceedings*.

Theory and practice

The theme of the congress was intended to stress the wide application of theory, the reliability of instrumentation, and the effectiveness of process control. Some people felt that it was questionable whether, on these particular grounds, the congress had achieved a satisfactory balance. The papers on theory were certainly the luxuriant growth. But the gulf between theory and practice was noticeably wide.

In the matter of practical applications, the contribution from Britain was untypically strong. Descriptions of automatic control in the manufacture of sugar were a good example of process-control work. A paper on ship stabilization indicated some of the heavy-weight applications of automatic regulation, and a comprehensive review of recent advances in the automation of steel was presented. Also, there was a very interesting discussion of the issues of automatic control in connection with British Railways.

No congress is complete without its social events, and these were quite impressive on this occasion. The famous Bolshoi Ballet came well up to expectations, with magnificent stage management. The banquet given in our honour was surprisingly elaborate and entered into with the verve we have read about. The climax was the distinction of a reception in the Kremlin Palace on behalf of the Academy of Sciences, in the almost breathtaking beauty of an exquisitely preserved banqueting hall.

Technical visits

Of many technical visits available it was not possible for anyone to undertake more than a few, but these had their own special interest. The Institute of Automation and Telemechanics of the U.S.S.R. Academy of Sciences in Moscow is well known for the quality of its theoretical work but is housed in a somewhat ramshackle building and follows the pattern of many other institutions in Russia in being virtually self-contained, with a high proportion of technicians and mechanics employed. Very interesting work on pneumatic and hydraulic systems under Prof. Aizerman was shown to us. We were also much intrigued by the work of the group under Prof. Feldbaum, working on self-adjusting systems and extremum regulators.

In Leningrad, which is a much more light-hearted city than Moscow, we visited the Institute of Electromechanics, where good work was being done on power-system analysis and an interesting group (again self-contained) was seen working on telescope-control systems. Finally in Kiev, which is in the up-and-coming part of the Ukraine, we visited the Institute of Automation. This is one of four such institutes existing in the Soviet Union at present. It is housed in a new building very different from that of the Institute of Automation and Telemechanics in Moscow. It is essentially a development establishment concerned with industrial applications of automation in the basic industries and chemical-processing industries. This Institute was the only place we saw that looked more or less as one would expect.

Although only 2½ years in existence, the laboratories were tolerably well equipped and the people working there seemed very enthusiastic about their jobs. As a result, a more comradely spirit seemed to exist there than at some of the other places we visited; the Director, Dr. Melnik, for example, moved freely among his people and talked to them as equals. Although we did not see much evidence of advanced automation during our tour, there is no doubt that, when the results of the activity of this Institute begin to percolate into industrial concerns generally, there will be a very great change in the effectiveness of those industries. It seemed to us pretty certain after visiting this place that the order 'go' on automation had been given by the higher authorities in Russia.

In the Russian manner

One should not, perhaps, end this account without commenting on the Russian habit of doing everything at the last possible moment and being always a little vague about the time. The atmosphere in which we had been living for a fortnight was that of a place apart, and, at the time, the Western world seemed rather far away. J. H. WESTCOTT

NEW TITLE FOR WIDENED SCOPE

THE Governors of the College of Aeronautics, Cranfield, Bletchley, Bucks., have decided to change the title of their Department of Aircraft Electrical Engineering to Department of Electrical and Control Engineering.

This new title will be introduced into College publications and records during the current academic year, so that it will become finally established by the beginning of the next session, in October 1961.

Since 1959 the College has been pursuing a policy of diversification of teaching activities, and as a result a number of new advanced courses have been developed in subjects which, although relevant to aeronautics, are of equal interest and value to many other branches of engineering. This policy applies to the newly-titled department, and it is thought that the new title will give a better indication of the scope of its activities. In addition to its normal function of providing specialist courses for aeronautical engineers as part of the two-year Diploma course, the Department of Electrical and Control Engineering is now offering advanced courses in industrial control engineering and flight control.

The department also provides specialist instruction for students of the courses in space technology and guided missiles.

TECHNICAL PUBLICATIONS

FURTHER information and copies of the publications can be obtained from the organizations concerned, except where otherwise stated

ACADEMIC PRESS

Advances in electronics and electron physics—Vol. XII. Photo-electronic image devices. Academic Press, New York and London, 1960. $12

THIS volume is the record of a symposium on image tubes and related devices held in London in September 1958. Papers include *inter alia* 'The potentialities of photo-electronic imaging devices for astronomical observations', 'Image tubes in nuclear physics', 'Some early trials of astronomical photography by television methods', and 'An image intensifier for the electron microscope'.

AMERICAN INSTITUTE OF PHYSICS

Proceedings of the fifth conference on magnetism and magnetic materials. McGraw-Hill, London, 1960. £3 17s. 6d.

THE conference, sponsored by the American Institute of Electrical Engineers, was held in Detroit from the 16th to 19th November 1959. The subjects covered include garnets; permanent magnets; magnetic modes; computers and switching; anisotropy, magnetic compounds and neutron diffraction; ferrimagnetic resonance; and magnetism in medicine. The material ranges from very specialized papers in theoretical physics to practical engineering applications. Other societies co-operating in the conference were the American Physical Society, the Institute of Radio Engineers, the Metallurgical Society of the A.I.M.E., and the Office of Naval Research.

AMERICAN RADIO RELAY LEAGUE

The A.R.R.L. antenna book. 9th edition. American Radio Relay League, West Hartford, Conn., 1960. $2

THE theory and practice of antennas for use by amateur radio operators are described in this book.

BRITISH POST OFFICE

Fourth report of the mobile radio committee. H.M.S.O., London, 1960. 9d.

RECOMMENDATIONS are made for increasing the number of v.h.f. channels for mobile-radio users. A channel width of 25 kc/s is to be adopted as standard in the 165–173 Mc/s band.

BUTTERWORTHS SCIENTIFIC PUBLICATIONS

Semiconductor technology. Butterworths Scientific Publications, London, 1960. 10s. 6d., postage 7d.

THE 12 articles contained in this book originally appeared as a series in *Research* in 1958 and 1959. They are intended to provide a simple survey of various topics in semiconductor technology.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE

Fire research 1959. Report of the Fire Research Board with the Report of the Director of Fire Research. H.M.S.O., London, 1960. 5s., postage 7d.

THE nearly completed study of fires of electrical origin during the year September 1957–August 1958 is referred to. Of the 6489 fires associated with electrical appliances, 57% were in dwellings and only 8·5% in factories. This is attributed to the facts that electricity is used principally for motive power in factories and that such installations are regularly inspected. With domestic appliances, cooking apparatus was the chief cause of fire, followed closely by space heaters. Some electrical appliances are becoming safer, notably refrigerators.

DIAMOND ORDNANCE FUZE LABORATORIES

Proceedings of the symposium on microminiaturization of electronic assemblies edited by E. F. Horsey. Chapman and Hall, London, 1960. £4 8s.

THE contents are divided into six sections: techniques; semiconductors; components; circuits; missile systems; and microelectronics in industry. Microminiaturization is defined as the design of electronic equipment to produce size and weight reductions of an order of magnitude below that of subminiaturization.

ELECTRICAL DEVELOPMENT ASSOCIATION

Farm electrification handbook no. 6. **Milling and mixing.** E.D.A., London, 1960. n.p.

THIS handbook deals with the electric milling and mixing of animal foodstuffs and the lay-out of the necessary equipment.

Farm electrification handbook no. 7. **Greencrop drying.** E.D.A., London, 1960. n.p.

ELECTRICAL methods of greencrop drying are discussed. There are chapters on equipment for electrical drying, dryers for loose hay, dryers for baled hay, etc.

ELECTRICITY COUNCIL

Utilisation research report no. 15. **Trials on six power station workers' houses with electric floor-heating.** Electricity Council, London, 1960. gratis

THE report analyses the results of trials of domestic floor-heating which were carried out in a terrace of six 3-bedroomed houses. These houses were equipped with especially high thermal insulation and with electric floor-heating in living-rooms and dining-kitchens.

HEYWOOD AND CO.

Cryogenics. An international journal of low temperature engineering and research. Heywood, London. Subscription rate £5 p.a. (four issues)

THIS new journal, whose first number appeared in September 1960, includes original papers on all aspects of low-temperature engineering and research. Each issue will contain one survey article; abstracts, in English, French, German and Russian, of cryogenic work published elsewhere; book reviews; a bibliography; and letters to the editors.

HILGER PUBLICATIONS

Fundamentals of digital instrumentation by D. S. Evans. Hilger and Watts Ltd., London, 1960. 7s. 6d., postage 6d.

THE monograph describes the basic principles of shaft-driven digitizers, and the author states that the problems are similar to those with other types of convertor. Coding, decoding, cycling, and sampling and storing are discussed.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Publication 51. **Recommendations for indicating electrical measuring instruments and their accessories.** Geneva, 1960. 33s. 9d. (French/English)

THIS publication applies to ammeters, voltmeters, single-phase and polyphase wattmeters, var-meters and phase-meters, frequency meters of the pointer and vibrating-reed types, and ohmmeters, and to certain accessories used with these instruments, such as shunts, series resistors, inductors and capacitors. Instruments incorporating devices such as rectifiers, diodes and thermocouples are covered, but electronic measuring instruments (including transistorized instruments) are excluded.

Publication 34–2. **Recommendations on determination of efficiency of rotating electrical machinery** (excluding machines for traction vehicles) 2nd edition. Geneva, 1960. 18s.* (French/English)

THIS edition differs from the 1955 one as regards recommendations concerning reference temperature, which were altered to take account of newer insulating materials, and the addition of clauses dealing with the determination of losses in d.c. motors and generators, polyphase induction motors and induction generators, and polyphase synchronous motors and generators.

Publication 52. **Recommendations for voltage measurement by means of sphere-gaps** (one sphere earthed). 2nd edition. Geneva, 1960. 18s.*

RULES are given for the construction and use of sphere-gaps for voltage measurement, whether alternating voltages, full standard impulses or impulses with longer tails, or direct voltages. Peak values of the disruptive voltages in air for various spacings between the spheres are given.

Publications 68–1 and 68–2. **Recommended basic climatic and mechanical robustness testing procedure for components for electronic equipment. 2nd edition.** Geneva, 1960. 68–1 18s.*, 68–2 £2 0s. 6d.* (French/English)

A STANDARD general procedure is described for climatic and mechanical-robustness tests, designed to assess the durability in various conditions of use, transport and storage of components used in telecommunication and electronic equipment.

Publication 121. **Recommendation for commercial annealed aluminium electrical conductor wire.** Geneva, 1960. 4s. 6d.* (French/English)

THE physical- and mechanical-property values of commercial annealed aluminium electrical-conductor wire having a diameter greater than 1 mm (0·039 in.) are prescribed.

Publication 119. **Recommendations for polycrystalline semiconductor rectifier stacks and equipments.** Geneva, 1960. £2 5s.* (French/English)

SELENIUM and copper-oxide stacks, rectifiers and rectifier equipments used for supplying d.c. power from a.c. sources up to 2 kc/s are covered by these recommendations, which, however, do not apply to telecommunication rectifiers, other than those for power supplies to such apparatus, or to rectifiers used as auxiliaries of measuring instruments.

Publication 124. **Recommendations for the rated impedances and dimensions of loudspeakers.** Geneva, 1960. 6s. 9d.* (French/English)

THE recommendations apply to single moving-coil (dynamic) loudspeakers of the direct-radiator type. Rated impedances of the moving coil and the fixing dimensions are given. Dimensional recommendations are limited to loudspeakers having cones of circular section.

NATIONAL COAL BOARD

Production Department Information Bulletin 60/219. **Non-destructive testing of colliery gear.** National Coal Board, London, 1960. n.p.

METHODS described include the use of radiography, ultrasonic and magnetic techniques, and penetrants. The apparatus needed is described, and practical applications and the interpretation of results are considered.

PERGAMON PRESS

Annual review in automatic programming—I. Pergamon Press, London, 1960. £3 3s.

THIS is the first of an annual series intended to record developments in automatic programming, and contains the 18 papers read at the conference on automatic programming of digital computers at Brighton in April 1959. Subsequent volumes will include original papers, reprints of papers, abstracts and critical reviews.

H. O. QUINN LTD.

Electrical engineering, radio and television diary 1961 edited by K. F. L. Withams. H. O. Quinn Ltd., London, 1960. n.p.

THE text of this diary includes electrical formulae; logarithmic tables; data on lamps, fuses, cables, coils, etc.; recommendations for television aerials and interference diagnosis; and a list of selected British Standards and Codes of Practice.

U.S. DEPARTMENT OF COMMERCE

NRL Report 5374. **An investigation of impulse-voltage breakdown in polyethylene.** U.S. Naval Research Laboratory, Washington, 1959. n.p.*

THE study of the characteristics of dielectric breakdown in commercial polythene, under applied high-voltage impulses, was divided into two parts: single-impulse breakdown during the rise of overvoltage impulses, and multiple-impulse breakdown at gradients below the threshold level for single-impulse breakdown.

U.S. DEPARTMENT OF COMMERCE: NATIONAL BUREAU OF STANDARDS

NBS Monograph 11. **Conductive flooring for hospital operating rooms.** National Bureau of Standards, Washington, 1960. 25 cents†

LABORATORY tests were undertaken to compare the physical, chemical and serviceability characteristics of available types of conductive flooring with those of non-conductive flooring. It was shown that the measuring instruments used affected the measured resistance of the floor. The results apply to locations other than hospitals where there is an accumulation of static electricity in the presence of explosive vapours.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

Guide to U.K.A.E.A. documents. 2nd edition. U.K.A.E.A., London, 1960. 1s. 6d.‡

THE guide explains how the authority publish information about their research, development, design and other work, and where new publications are announced; how the authority is organized, and by which of their establishments information is published.

UNITED NATIONS

Rationalization of electric power consumption. United Nations, Geneva, 1960. 2s. 6d.§

THE national organizations dealing with the problem of rationalization of electric-power consumption, the methods used and the results obtained are given in this document.

Organization of electric power services in Europe. 2nd edition. United Nations, Geneva, 1960. 5s.§

INFORMATION from various countries on the organization of Government services, of private or nationalized undertakings, and of associations of such undertakings, and on certain bodies conducting research and publicity, together with notes on international organizations dealing with electric power, are contained in this document.

* Obtainable from the Sales Department, British Standards Institution, 2 Park Street, London W.1.

* Obtainable from U.S. Department of Commerce, Office of Technical Services, Washington 25, D.C.
† Obtainable from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.
‡ Obtainable from H.M. Stationery Office
§ Obtainable from Sales Section, European Office of the United Nations, Palais des Nations, Geneva, Switzerland

LIBRARY ACCESSIONS

** Denotes that the publication is also in the Lending Library. The publications cannot be bought through The Institution; the publishers and the prices are given only for the convenience of members*

BOOKS

AMERICAN RADIO RELAY LEAGUE 621.396.029.58

The mobile manual for radio amateurs. 2nd edition

West Hartford: American Radio Relay League, 1960. pp. 282. 24 × 16cm. 17s. 6d.

A collection of over 80 articles, previously published in *QST*, dealing with receivers, transmitters, antenna, power supplies and portable and emergency equipment.

ANDRADE, E. N. da C. 93: 06

A brief history of the Royal Society

London: The Royal Society, 1960. pp. 28. 26 × 17cm. 10s. 6d.

AUGER, R. W. 621.318.5

The relay guide; a compendium of electromechanical relays marketed in the United States*

New York: Reinhold. London: Chapman and Hall, 1960. pp. xv, 383. 29 × 22cm. £4

Illustrates and describes nearly 1000 relays in 33 groups, including general purpose, telephone, power, miniature, rotary, vacuum, polarized, high-speed, mercury, and time-delay. Information is also included on arc-suppression techniques, contact ratings, testing, etc.

BRILLOUIN, L. 530.145

Wave propagation and group velocity*

New York and London: Academic Press, 1960. pp. xi, 154. 23·5 × 15·5cm. £2 8s.

Consists mainly of a translation of papers published by Sommerfeld and Brillouin in 1914 on wave motion in dispersive media and Brillouin in 1932 on propagation in ionized media, with a final chapter on waves in pipes. This book was reviewed in the August 1960 *Journal*, p. 501.

COTTON, H. 621.313.3

Alternating current machines. 2nd edition*

London: Cleaver-Hume, 1960. pp. 328. 19 × 12·5cm. 21s.

An explanation of the operating characteristics of the various types of a.c. machine including the small commutator motor widely used for domestic appliances. The use of M.K.S. instead of C.G.S. units is adopted in this edition.

COTTON, H. 621.31

Basic technical electricity. 3rd edition*

London: Cleaver-Hume, 1960. pp. 246. 19 × 12·5cm. 12s. 6d.

This is in part adapted from the author's 'Principles of electricity'. It is the first of a series intended for spare-time students and gives the fundamentals on which the subject-matter of the others in the series is based. The chief alteration in this edition is the use of the M.K.S. system and the rewriting of the chapter on units.

COTTON, H. 628.9

Principles of illumination*

London: Chapman and Hall, 1960. pp. xiii, 526. 22 × 14cm. £3 15s.

Deals with the fundamentals of the subject and is intended to meet the needs of students taking Part III of the Institution Examination. This book was reviewed in the November 1960 *Journal*, p. 666.

DAY, W. D. 517

Introduction to Laplace transforms; for radio and electronic engineers*

London: Iliffe. New York: Interscience Publishers, 1960. pp. vii, 183. 22 × 14cm. 32s. 6d.

This is a book for those with a working knowledge of circuit principles and elementary differential equations. The method is approached via the solution of second-order equations rather than through the Fourier integral and transform. The treatment is not rigorous, and formal proofs are omitted where they add little to the understanding. This book is reviewed on p. 729.

EGGINTON, H. H. 621.56

Refrigeration controls*

London: Refrigeration Press, 1960. pp. 157. 19 × 12cm. 15s.

A practical introduction to the design, functioning and application of the various pressure-operated and thermostatic types of control.

ELLIOTT, A., and DICKSON, J. H. 681.2

Laboratory instruments; their design and application. **2nd edition, revised***

London: Chapman and Hall, 1959. pp. xvi, 514. 22 × 14cm. £2 15s.

Discusses the properties of various materials used in the construction of instruments. The kinematics of the design of instruments, vibration insulation, sensitivity and other problems are dealt with. The use and working of glass, optical instruments and applications of photography are the subjects of separate chapters.

HANSFORD, R. F. (*Editor*) 621.396.93

Radio aids to civil aviation*

London: Heywood, 1960. pp. xvi, 623. 25 × 15·5cm. £6 6s.

After an introductory chapter on principles of radio; aircraft communication systems; *en route* aids; aids to traffic control; approach, landing and surface movement; weather radar; and radar links are discussed in detail from the point of view of operational problems and present trends in the development of the various systems. This book will be reviewed in a future issue.

HOLES, K. A. 53 (076)

Laboratory manual for National Certificate*

London: English Universities Press, 1960. pp. xiii, 104. 22 × 14cm. 8s. 6d.

Consists of experiments in engineering science, applied mechanics, and applied heat, for students taking Ordinary National Certificate courses. Some require special apparatus and will have to be carried out in the college laboratory, but a number could be improvised in the home or workshop.

MANTELL, C. L. 621.35

Electrochemical engineering. 4th edition*

New York and London: McGraw-Hill, 1960. pp. x, 680. 23·5 × 16cm. £6 18s.

Apart from a short section on theoretical electrochemistry, it deals with industrial processes (including electroplating), furnaces, electrochemistry of gases, corrosion, and batteries. It also discusses power supplies and materials.

MURPHY, G. M. 517

Ordinary differential equations and their solutions*

New York and London: Van Nostrand, 1960. pp. ix, 451. 23·5 × 15·5cm. £3 4s.

A comprehensive collection of methods for solving ordinary differential equations, with a tabulation of some 2000 differential equations and their solutions.

ROGERS, G. F. C., and MAYHEW, Y. R. 536.7

Engineering thermodynamics work and heat transfer*

London: Longmans, 1959. pp. x, 619. 23 × 15cm. £2 10s.

Covers the fundamentals of applied thermodynamics up to honours degree standard.

SCHWARTZ, S. (*Editor*) 621.314.7

Selected semiconductor circuits handbook*

New York and London: John Wiley, 1960. pp. xiv, 503. 24 × 15cm. £4 16s.

Gives 150 circuits with detailed design information. They are arranged in sections, e.g. amplifiers, oscillators, switching circuits, and there is a bibliography with each section. Unfortunately, there is no index but only a fairly detailed contents list. This book will be reviewed in a future issue.

SEIFERT, W. W., and STEEG, C. W., Jr. (*Editors*) 621–52

Control systems engineering*

New York and London: McGraw-Hill, 1960. pp. xiv, 964. 26 × 19cm. £5 16s. 6d.

A mathematical work on the analysis and synthesis of large-scale automatic-control systems. It is based on lectures given at the Massachusetts Institute of Technology to advanced students.

SPALDING, D. B., and COLE, E. H. 536.7

Engineering thermodynamics; an introductory text*

London: Edward Arnold, 1959. pp. viii, 383. 23·5 × 15cm. 28s.

Covers a first-year course for university students of mechanical, aeronautical, civil and electrical engineering.

VRIES, L. de 413 = 30

German–English technical and engineering dictionary; supplement

New York and London: McGraw-Hill, 1959. pp. xxvii, 386. 23 × 15cm. £4 9s.

This supplementary volume contains some 50000 terms coined since the original work was published in 1950. The scope includes all aspects of engineering and technology, optics, photography and nuclear physics.

OTHER PUBLICATIONS

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Proceedings of the national telemetering conference, 23rd–25th May 1960, Miramar Hotel, Santa Monica, California, sponsored by the American Institute of Electrical Engineers, American Rocket Society, Instrument Society of America, Institute of Aeronautical Sciences, and the Institute of Radio Engineers

Santa Monica: National Telemetering Conference, 1960. pp. 870. 28 × 21·5 cm. n.p.

BELMOS COMPANY LTD.

Simplified short-circuit calculations by R. T. Lythall

Bellshill, Lanarkshire: Belmos Co. Ltd., 1960. pp. 28. 22 × 14·5cm. 5s.

BRITISH BROADCASTING CORPORATION

A new survey of the B.B.C. experimental colour transmissions by I. R. Atkins and others. Engineering Monograph 32

London: B.B.C., 1960. pp. 31. 28 × 21·5cm. 5s.

BRITISH POST OFFICE

Fourth report of the mobile radio committee

London: H.M. Stationery Office, 1960. pp. 9. 24·5 × 15cm. 9d.

UNITED NATIONS

Organization of electric power services in Europe. 2nd edition

Geneva: United Nations, 1960. pp. 103. 28 × 21·5cm. 5s.

Rationalization of electric power consumption

Geneva: United Nations, 1960. pp. 25. 28 × 21·5cm. 2s. 6d.

FONDATION UNIVERSITAIRE

Increasing the effectiveness of Western science

Brussels: Fondation Universitaire, 1960. pp. 19. 27 × 21cm. n.p.

NATIONAL ACADEMY OF SCIENCES—NATIONAL RESEARCH COUNCIL

Digest of literature on dielectrics, 1959—Vol. 23

Washington, D.C.: National Academy of Sciences—National Research Council, 1960. pp. 423. 28 × 21·5cm. £2 17s.

NEW ZEALAND ELECTRICITY DEPARTMENT

Report of the committee to review power requirements

Wellington, N.Z.: New Zealand Electricity Department, 1960. pp. 24. 24·5 × 15cm. n.p.

Report of the planning committee on electric power development in New Zealand

Wellington, N.Z.: New Zealand Electricity Department, 1960. pp. 11. 24·5 × 15cm. n.p.

OFFICE OF NAVAL RESEARCH AND THE ELECTROCHEMICAL SOCIETY

The surface chemistry of metals and semiconductors. A symposium sponsored by the Office of Naval Research and the Electrochemical Society, Columbus, Ohio, 1959, edited by Harry C. Gatos

New York and London: John Wiley, 1960. pp. 526. 23·5 × 15cm. £5

SWEDISH STATE POWER BOARD

Stability studies on the Swedish 400kV transmission system. Blue-white series 28

Stockholm: Swedish State Power Board, 1960. pp. 27. 30 × 21cm. n.p.

SIZEWELL NUCLEAR POWER STATION

THE Central Electricity Generating Board announced their intention to place a contract for the building of a nuclear power station at Sizewell, Suffolk.

Two carbon-dioxide-gas-cooled graphite-moderated natural-uranium-fuel reactors will be used, operating on the same principle as those for the stations already being built for the Board.

One feature of the station is that circulating water, which is drawn from and returned to the sea, will not come into direct contact with either the steam employed to drive the turbines or the carbon dioxide used to remove heat from the reactors.

The Board made application to the Minister of Power for consent to build the Sizewell station in January 1959, and this consent was granted in February 1960 without the need for a public inquiry.

Five nuclear power stations are now under construction for the Central Electricity Generating Board: at Berkeley, Gloucestershire (275MW); Bradwell, Essex (300MW); Hinkley Point, Somerset (500MW); Trawsfynydd, Merionethshire (500MW); and Dungeness, Kent (550MW). The Minister of Power has recently given consent to build a seventh station at Oldbury upon Severn, Gloucestershire.

Elections and transfers

The following elections and transfers approved by the Council of the Institution are effective from the 1st November 1960

ELECTIONS

Associate Members

ADAMS, Kenneth Henry James, B.SC.
BISHOP, David Kenneth, B.SC.
BODEN, Peter
BROWN, John Malcolm
BRUCE, William Henry
BURKE, Patrick Anthony
CALDWELL, John Henry, B.SC., B.E.
DILLON, James Thomas, B.E.
DOBSON, Robert McDowell
JOHNSTON, Arthur Ernest, B.SC.
LORD, Peter, B.SC., M.SC.TECH., PH.D.
MAYES, Eric Henry
ORTON, Clifford Austin
OSBOURNE, Robert Ian, B.SC.(ENG.)
O'SHEA, James Patrick, B.SC.
PILKINGTON, Garnier David
RIDER, Ronald Arthur
ROONEY, Brian Padraig Michael, M.A.
SAUNDERS, Harry, B.SC.(ENG.)
SZARVAS, Gyorgy, DIPL.-ING.
WOLF, Ernest
YOUNG, Stuart Kennedy Murray

Associates

OSBORNE, Leonard Hartley
STATHER, Hubert

TRANSFERS

Associate Member to Member

CURRY, William James John, PH.D., B.SC.
FULLER, Raymond Alan, B.SC.(ENG.)
GILES, Henry James
GORDON, Lt.-Col. Patrick Hunter, M.A.
HAIGH, Robert Douglas, M.ENG.
KORAM, Edmund Manteaw, B.SC.(ENG.)
LOADER, Herbert Marston, D.F.H.
MASTERS, Philip James, B.SC.(ENG.)
PAINTING, William Arthur Ernest
PAULS, William
PICKLES, Thomas, B.SC.(ENG.)
SHARPE, Robert Grahame, B.SC.(ENG.)
SPOONER, Jack Walter
YOLLAND, Brig. Robert Gifford, M.A.
ZUBAIR, Syed Mohamed, M.S.

Graduate to Associate Member

AITKEN, William Roy Osbourne, B.SC.
ALLEN, George Martin, B.SC.(ENG.)
BAINES, John
BARDWELL, Brian William, B.SC.(ENG.)
BOOTH, Brian
BRAMELLER, Alfred
BRAZIER, Ronald Frederick
BRIGHTING, Peter Kaye
BRODIE, David
BROWN, Kenneth Robert
BUDDLE, Kenneth Brunswick
CALDER, Graham Scott Wight, B.SC.(ENG.)
CHAMBERLAIN, Neville Cyril
CHANDRA, Lt.-Cmdr. Ramesh, B.SC., D.F.H., I.N.
CLEAVER, Patrick Daniel Friend
COATES, Kenneth Arthur James
CRORIE, William Douglas, B.SC.(ENG.)
CROUCHER, Douglas
CUTHILL, Ian Alexander
DARVENIZA, Mat, B.E., PH.D.
DAVIS, Desmond Rhodes, B.SC.
DAWS, Sailajanada, B.SC.
DENMAN, William Leslie
DRAKE, Ronald Edgar, B.SC.(ENG.)
GEER, Peter Kenneth
GHOSH, Sailendra Nath, M.SC., F.H.-W.C.
GOODWIN, David
HEATHERINGTON, John Graham, B.SC.
HIGGS, Peter
HOBBS, Robert Lamont
HOLDER, John Eric
HOWARD, Peter Eric
HOWELLS, Mervyn, B.SC.
HUGHES, Harold George Douglas
JOHNSON, Robert Cyril, B.SC.(ENG.)
KENDRICK, Stanley Harry
KETTLETY, Arthur
LEESON, John Edward
LLOYD, Norman
LUTHER, Stuart Frank, B.SC.
MORAN, Thomas Alfred
NANCARROW, Teddy
PICKLES, Ronald
PORTER, Alfred Derek Norman
PROCTOR, William Gerald, M.A.
QUESTED, Derek Ray, B.SC.
RAMSAY, William Alistair
RAWLINGS, Gordon William
ROFFEY, George Frederick
SAGE, Peter Kennedy
SALTER, John Howson
SHADBOLT, Frederick Walter
SINDEN, Michael Hugh
SINGARAJAH, Christopille, B.SC.(ENG.)
SMITH, Roderick Maclean
SPRATT, William Noel
STEAD, Norman, B.ENG.
TOD, James
TOLCHER, Roy
TUCKER, Eric Cecil Maurice
WALKER, William Terence, B.SC.(ENG.)
WALLIS, Alan Dennis
WATSON, Alexander Smith, B.SC.(ENG.)
WEEKS, Derek Vine
WILSON, John Brian
WOOD, Herbert John

The following elections and transfers approved by the Council of The Institution are effective from the 3rd November 1960

ELECTIONS: 1st LIST

Graduates

BURROWS, John Henry, B.SC.(ENG.)
CHINN, Henry Ronald, B.E.
CHRISTOPHERS, William Matthew
COOKE, William Montgomery

Graduates (continued)

CREERY, Desmond Anthony, B.SC.
FLOOD, Peter Victor
HOCKNEY, Capt. Barry Herbert, B.SC.
HUME, Peter Hamilton, B.E.
JORDAN, Clifford Grafton Liberton
LINGAM, Vythilingam Rama
MACINTYRE, Duncan James
MCCORMACK, Percival Davis, B.A., B.SC., PH.D.
MORRIS, David Barrie, B.SC.
QUAYLE, George Philip, B.A.
ROYLE, Albert Arthur
SMART, John Robert
SOETRATMA, Djaka, B.E.
VINCE, John Robert, B.A.
WATERFIELD, William

Students

ADLER, Patrick Anthony
ATKINSON, Peter
BENTLEY, David Frederick
BHARDWAJ, Ved Parkash
BLACKLOCK, Ernest
BRASH, Harry Melrose
BURROUGHS, Richard Arthur
CALLAWAY, Anthony Albert
CHAWLA, Sushil Kumar, B.SC.
CONNOLLY, David Charles Antony
CORY, Frederick John
CURLEY, Wilfred Bernard
DIGBY, Peter Charles
EASTHILL, Rodney Albert
FREEMAN, Barry Claude
GASKILL, James Harry
GITTENS, Andrew Aubrey
GOSLING, Gordon Grenville
GOY, Cedric John Aldis
GREEN, Peter John
GREENWOOD, John
GRIFFITHS, John Keith
HAIGH, Geoffrey
HARKER, John Edward
HARKIN, Oliver John
HILLARY, John Barratt
HOLDEN, Thomas Geoffrey
HORNBY, Derek Gregory
HOUSLEY, Norman
HOWARTH, Neil Frederick
INMAN, George Daniel
JOHNSON, Lancelot George
JONES, Brian
KEEFE, Arthur Thomas
KING, John Alan
LANE, Colin
LEE, Philip William
LOCK, Robin
LOCKEY, Frederick
LYNCH, Gary James
MCCONKEY, George Charles Clinton
MCGLINCHY, Brian John
MCKEE, Stanley Hodgson
MATTHEWS, Henry Joseph
PATRICK, Roger
PEACE, Leonard
POIZER, David Thomas
PREMADASA, Andra Hennadige, B.SC.
PRITCHARD, Ieuan Owen
RAJARATNAM, Joseph Maduranayagam
RAMSBOTTOM, Thomas Anthony
RAYNER, Ralph William
REDMILE, Graham John
RIGG, George Price, B.SC.
SAGGAR, Ram Krishan
SIMPSON, George Alexander
SMITH, Raymond Charles
SYMMONDS, Francis Trevor
TAIT, George Douglas
THOMAS, David Knight
TUDOR, David Robert
VAN EETVELT, Peter William Joseph
WALLS, Reginald
WARD, Kenneth
WATKINS, Laurence Shrapnell
WEATHERLEY, Raymond Thomas
WELSH, John Rule
WILLIAMSON, Eric
YOUNG, Edmund

TRANSFERS

Student to Graduate

ADAMSON, Francis Ian, B.SC.
BARTON, Roy, B.SC.
BLYTHIN, Peter Samuel, B.SC.
BRADLEY, David Nicholas, D.L.C.
CHALKER, David Michael Cyril, B.SC.(ENG.)
CHAN, Bill Ling, B.SC.(ENG.)
CLARK, Richard Ivric, B.ENG.
COCKHEAD, John Cyril Roy, B.SC.
COLSTON, John Matthew, B.SC.
CRAWLEY, Brian Frederick, B.SC.TECH.
DAVIDSON, Robert Nesbitt, B.SC.
DENNEY, Ian Alexander, B.SC.
DUFFY, Rodney Michael, B.E.
FAIRMANER, Denis, B.SC.
FOLKES, Michael Patrick, B.SC.TECH.
GODIER, Roy Frederick, B.SC.
GREGOR, Alexander William, B.E.
HALL, Eric, M.SC.
HALL, Graham, B.SC.
JOHNSON, David William, B.SC.(ENG.)
KOUSSOULOS, Michael George, B.SC.
LAWTON, Charles Roger, B.SC.TECH.
LEAN, Chin-Keat
LEVETT, Jeffrey, B.SC.
MCCONNELL, Peter Orran, B.SC.
MCFARLANE, James Angus, B.SC.
MAYNE, John Eric, B.SC.(ENG.)
MORGAN, Brian Eric, B.SC.
MORGAN, Stuart Llewellyn Gwyn, B.E.
ODELL, Peter Martin, B.SC.(ENG.)
PARNELL, Michael David
PATHAN, Mujeebdad Khan H., M.SC.
PERERA, Peter Edmund
PERRY, Guy Edward Adolphus
PROBERT, Eric David, B.SC.(ENG.)
REDHOUSE, Anthony Keith, B.SC.
ROBERTS, Peter Kemp, B.SC.
ROBINS, David Gerald, B.SC.
SHEMMANS, Malcolm John, B.SC.(ENG.)
SHERIDAN, Phillip Robert, B.SC.(ENG.)
SLATTERY, Robert Lindsay, B.SC.TECH.
STOPFORD, Graham Molyneux, B.SC.TECH.
THOMPSON, John Anthony, B.SC.
TRATT, John Herbert, B.SC.
VARMA, Nareshkumar Jaikrishna, B.SC., B.SC.(ENG.)
WARZYBOK, Edward
WATTS, Charles Lyle, B.SC.TECH.
WHEATLEY, Clifford Walter Robertson, B.SC.
WHITMELL, Brenda Constance, B.SC.
WOOD, Peter John, B.SC.

ELECTIONS: 2nd LIST

Graduates

AUCKLAND, Kenneth John
BEAUMONT, Brian Norman
BULLOCK, Colin Joseph, B.SC.
CAMPBELL, Joseph, A.R.C.S.T.
CHAPMAN, Alton Victor
CHARLESWORTH, David Allan, B.E.
COOKE, Geoffrey Herbert, B.SC.(ENG.)
CORMACK, Robert John, B.SC.

Graduates (continued)

CRAWFORD, Leslie Gordon, B.SC.
FOSTER, Arthur William
LAVERY, Christopher Soward, B.E.
LEHANE, Liam Aidan, B.E.
LINES, Peter William
MARSHALL, Michael John, B.SC.
MOKHTAR, Taib
PALMER, Lt. Alan Edward, B.A., R.N.
PRESTON, John Michael, B.A.
SARVARY, Gabor Jeno, B.A.
SHORT, Allan
SMITH, Harold Ernest
WILKINSON, George Alwyn Keith, B.SC.
WILLIAMS, Brian, B.SC.(ENG.)
WRIGHT, William

Students

ASHEN, David John
AYRES, James Albert
BEAUFOY, Derek Stanley
BOWYER, John Alfred
BRADSHAW, Gordon William
CANDY, Geoffrey William
CARNELL, George David
CARRINGTON, Dennis
CARROLL, John Brian
CARTER, Christopher Gregor
CARTWRIGHT, George
CHIU, Kin-Pon
COMBER, Frederick George
COPPEN, John David, B.SC.
CORNISH, Charles Brian
COUSENS, Richard James, B.SC.
CROOM, Martin Robert
CUMMING, Allan Alexander
CUNDY, David Reginald
DANIELS, Anthony Walter Robert
DORE, John Raymond
FRY, Charles Rodney
GIBBS, Alan Edward
GOURLAY, John Arthur
GRANT, William Thomas
GUPTA, Ramesh Jawamarlal
HENDERSON, David Ian
HEWSON, Dennis
HODGKINSON, Harry, B.SC.
HODGKINSON, Joseph Patrick
HOYLE, Arthur Robert
JOHNSON, Kenneth Robert
JONES, Michael John
JONES, Peter David
KATELI, Farrokh Khurshed
KISTOSTURIAN, Haig Gregory, B.E.
LAKE, Brian
LEAMAN, Kenneth Edwin
LEAVER, Felix Pearson
LOVESEY, Paul John
MERDITH, Richard Garfield
MILLWARD, Geoffrey Frederick Dalton
MOORE, Lawrence Edward
NANGIA, Vijay Kumar, B.E.
NEWTON, John
PAGET, Ian Richard
PANDYA, Kirit Chandrakant, B.E.
PARULEKAR, Subhash Vishnu, B.E.
PAYNE, Robert William
PAYNE, Roy David
PEDRISA, Luis Lawrence
PERRING, Roy Francis
PETRIE, Victor
PIPER, Derek
PLASTER, Dennis
PRATT, David Michael
PRIESTMAN, Timothy John
RAJARATNAM, Murugesapillai
ROBERTS, Peter David
ROGERS, Raymond Charles
ROWLINSON, John Smales
RUST, Barrie Christopher
SIMMONS, Alan
SIMS, Barry
SMITH, Trevor Dealtry
STALLARD, George William
STONE, William Charles
SURENTHIRAN, Rajas
TOURLE, Neil Peter
TULIP, Arthur, B.SC.
VICKERS, Alan James
WALSH, Edward
WARBURTON, Clive Rowland
WARD, Leopold Anthony
WHITTLE, Garry
WIJERATNE, Warusahannedige Vineethewansavijaya Soysa
YELL, Ralph William

TRANSFERS: 2nd LIST

Student to Graduate

AU, How Kee, B.SC.(ENG.)
BAKER, Roy Dixon, B.SC.
BOUCHER, Franklin Christopher, B.SC.(ENG.)
BOWLES, John Patrick, B.SC.(ENG.)
BRINDLEY, John William, B.SC.(ENG.)
COLLIN, David John, B.SC.(ENG.)
CURTIS, Thomas Anthony
D'AGOSTINO, Laurence Cormack, B.SC.(ENG.)
DEVEREUX, Jeffrey Reginald, B.SC.(ENG.)
EDWARDS, David Michael
ELLIS, John Edward, B.SC.
FAJEMIROKUN, Christopher Lawrence Monisoye
FRASER, Kenneth Charles, B.SC.(ENG.)
FRY, Bryan Edwin Thomas, B.SC.
GENT, Alan Edwards, B.SC.
GRIME, Barry Millward, B.SC.(ENG.), M.S.E.
HAMMOND, Michael, B.SC.
HAQUE, Shah Mobinul, B.SC.(ENG.), M.SC.(ENG.)
HARDY, Brian John, B.SC.(ENG.)
HEATON, Reginald George, B.SC.TECH.
HILL, Keith Ronald, B.SC.
HORRITT, Lawrence, B.SC.(ENG.)
HUGHES, Thomas George, B.SC.
JENKINS, Peter Howell, B.SC.
KENNEDY, Ian Anderson Bullard, B.SC.
KINDELL, Hugh Wellesley, B.SC.(ENG.)
MCKAY, Ross Oliver, B.E.
MANN, Robert John, B.SC.(ENG.)
MARTIN, Anthony John, B.SC.
PARIKH, Krupesh Kumar Kanchanlal, B.SC., B.SC.(ENG.)
ROBINSON, Colin, B.SC.TECH.
STEADMAN, David Rosslyn Ayton, B.SC.(ENG.)
SULTAN, Nizar Badih, B.SC.
TRACEY, Gordon Edgar, B.SC.
WALLACE, Peter
WILLIAMS, Howard Bradbury, B.SC.
WILLIAMS, John Victor, B.SC.
WILLIAMS, Peter Emrys, B.SC.(ENG.)

OVERSEA ATTENDANCE REGISTER

DURING the period 17th October to 16th November 1960, these members called at the Institution building and signed the Attendance Register of Oversea Members:

DAYAL, M. (**Bombay**)
GHOSE, S. N. (**Calcutta**)
KING, J. A. C. (**Emgu, E. Nigeria**)
MEEK, J. (**Madras**)
RAJADYAX, L. M. (**Bombay**)
SAYLE, T. G. (**Episkopi, Cyprus**)
SRIVASTAVA, A. S. (**Gaya, India**)
STOCK, J. M. (**Kampala, Uganda**)
STUTCHBURY, G. J. (**Sydney**)
TAMBIPALLAI, S. G. K. (**Colombo, Ceylon**)
TODD, R. F. (**Aden**)
TRUSS, H. W. (**Caracas, Venezuela**)
TUDHOPE, G. W. (**Cape Town**)

Forthcoming events at Savoy Place

ALL meetings are held at Savoy Place, beginning at 5.30 p.m. (tea at 5 p.m.), except where otherwise stated. The nature of the meeting is indicated by the following key:

ED EDUCATION DISCUSSION CIRCLE
E ELECTRONICS AND COMMUNICATIONS SECTION
M MEASUREMENT AND CONTROL SECTION
MED MEDICAL ELECTRONICS DISCUSSION GROUP
O ORDINARY
S SUPPLY SECTION
U UTILIZATION SECTION

After each paper that has now been published is added the month when a synopsis appeared in the *Journal* under 'Papers and monographs published individually this month', i.e. about the time when the paper was published as a separate. A paper that has not yet been published will be available at least ten days before the meeting at which it will be read. The full list of London meetings is given in the meetings card, which is available on request from the Secretary of The Institution

December 1960

M **20** *Tuesday* L. AIREY, B.SC., will open a discussion on 'Digital transducers'†

E **21** *Wednesday* L. J. WARD, B.SC.TECH. Lecture on 'Microminiaturization'†

January 1961

O **5** *Thursday* J. S. FORREST, D.SC., M.A. Third Hunter Memorial Lecture. 'The application of electronics to the electricity supply industry'‡

MED **6** *Friday* D. G. HALEY *and* J. BOUGLÉ will open a discussion on 'Image-intensification techniques in radiology'* (at 6 p.m., tea at 5.30 p.m.)

E **9** *Monday* G. H. METSON, M.C., D.SC., PH.D., M.SC., B.SC.(ENG.), *and* EDITH MACARTNEY, M.SC., B.SC. Lecture on 'Recent research in thermionics'†

M **10** *Tuesday* G. H. RAYNER, B.A., *and* A. FELTON, B.SC.(ENG.). Lecture on 'Precision measurement'†. Supported by these papers: G. H. RAYNER, B.A., *and* L. H. FORD, M.SC. 'Improvements in the precision measurement of capacitance' (paper 3159M) *synopsis:* see p. 726; S. HARKNESS *and* F. J. WILKINS 'The design of an audio-frequency amplifier for high-precision voltage measurement' (paper 3335M) *synopsis:* October 1960; J. J. HILL, B.SC., *and* A. P. MILLER 'The design and performance of high-precision audio-frequency current transformers' (paper 3296M) *synopsis:* September 1960; J. J. HILL, B.SC. 'Techniques for the calibration of standard current transformers up to 20kc/s' (paper 3297M) *synopsis:* September 1960

U **12** *Thursday* O. I. BUTLER, D.SC., *and* V. AHMAD, PH.D. 'A new form of crane-hoist control using a 3 : 1 pole-changing induction motor' (paper 3226U) *synopsis:* March 1960

U **13** *Friday* Section Dinner-Dance (at the Café Royal, London, at 7 for 7.30 p.m.)

S **18** *Wednesday* M. N. JOHN, B.SC. 'A general method of digital network analysis particularly suitable for use with low-speed computers' (paper 3259S) *synopsis:* May 1960; P. P. GUPTA, PH.D., B.SC., *and* PROF. M. W. HUMPHREY DAVIES, M.SC. 'Digital computers in power-system analysis' (paper 3484S) *synopsis:* see p. 726

ED **20** *Friday* G. S. C. LUCAS, O.B.E., F.C.G.I., will open a discussion on 'Management studies for junior engineers'* (at 6 p.m., tea at 5.30 p.m.)

M **24** *Tuesday* E. H. FROST-SMITH, B.A., PH.D., will open a discussion on 'Machine-tool control'†

E **25** *Wednesday* W. E. WILLSHAW, M.B.E., M.SC.TECH. Lecture on 'Generation and amplification in the millimetre-wave field'†

* No advance information will be available and no Press report will be permitted
† An abstract will be available in advance
‡ No advance information will be available

District Meeting

ARRANGEMENTS for a District Meeting in January 1961 other than in the area of a local Centre

January 1961

READING (at the George Hotel, King Street, at 7.15 p.m.)
16 *Monday* Open forum

ANNOUNCEMENTS TO MEMBERS

THE HOMES FUND

SUMMARY OF CONTRIBUTIONS RECEIVED TO 9TH NOVEMBER 1960

	no. of contributors	£	*s.*	*d.*
£1000 and over	8	8685	0	0
£100 to <£1000	32	7181	3	0
£5 to <£100	923	9644	19	7
£2 to <£5	2287	6312	18	10
under £2	29110	15309	6	8
		47133	8	1

APPOINTMENTS AND NOMINATIONS

WIRING REGULATIONS COMMITTEE

ON the nomination of the Electrical Contractors' Association of Scotland, the Council have appointed Mr. A. C. C. Smith, ASSOCIATE MEMBER, to succeed Mr. H. C. Mackerron, B.SC., ASSOCIATE MEMBER, on the above committee.

JOINT B.S.I./I.E.E. SUB-COMMITTEE ON RADIO INTERFERENCE FROM IGNITION SYSTEMS (from ELE/32/2)

The Council have appointed Mr. E. L. E. Pawley, O.B.E., M.SC.(ENG.), MEMBER, to succeed the Hon. R. T. B. Wynn, C.B.E., M.A., MEMBER, who has hitherto served as one of the nominees of the Council on the above sub-committee.

B.S.I. NUCLEAR ENERGY INDUSTRY STANDARDS COMMITTEE

The Council have nominated Mr. H. West, M.SC., MEMBER, as their representative on the above new committee.

B.S.I. TECHNICAL COMMITTEE ELE/4—ELECTRICAL ACCESSORIES

The Council have nominated Mr. T. A. Frazer, M.A., MEMBER, as their representative on the above committee in succession to Mr. B. Donkin, B.A., VICE-PRESIDENT, who wishes to discontinue his service on the committee.

THE FARADAY LECTURE IN LONDON

THE Faraday Lecture will be delivered by Mr. L. J. Davies, C.B.E., M.A., B.SC., MEMBER, at the Central Hall, Westminster, London S.W.1, on Thursday 16th February 1961, at 6 p.m., his subject being 'Transistors and all that'.

The primary object of the Faraday Lecture is to increase the interest of the general public in electrical matters, particularly those having an immediate bearing on the life of the community; **members are therefore asked to bring the Lecture to the notice of their friends.**

Admission is free by ticket obtainable from the Secretary of The Institution; members are requested to enclose a stamped addressed envelope with each application.

The Lecture answers these questions about transistors: what do they look like; what can they do; how are they made; what is a solid and how is electricity conducted through it; how is electricity conducted through gases and liquids; why are the semiconductor solids different from others, with special control of the minute traces of impurities on which their action depends; how can we make from them rectifiers, transistors, refrigerators and heat pumps, photoelectric power generators for satellites, and thermoelectric power generators for waste or other heat; how are we at present using transistors and other semiconductor devices; and how are they likely to affect our future?

Mr. Davies is director in charge of Research and Education of Associated Electrical Industries (Rugby) Ltd.

GROUPS OF PROFESSIONAL ENGINEERS

THE Council of The Institution, acting jointly with the Councils of The Institution of Civil Engineers and The Institution of Mechanical Engineers, have approved Regulations for Groups of Professional Engineers under which it will be permissible for the Joint Groups of the three institutions which have been formed in a number of countries oversea to extend their membership to include members of those societies which support the Commonwealth Engineering Conference and the Conference of Engineering Societies of Western Europe and the United States (EUSEC), and also a number of British societies in associated fields.

It is left to the Committee of each Joint Group to decide whether they wish to extend their membership within the new regulations. The Committees of the Trinidad and Tobago Joint Group and the Gibraltar Joint Group have so far announced their intention to operate in future as Groups of Professional Engineers.

MICROWAVE MEASUREMENT TECHNIQUES

WITH the support of the Council of The Institution, the Electronics and Communications Section will hold a conference on microwave measurement techniques at Savoy Place from the 6th to 8th September 1961. The subject-matter of the conference will include the measurement of microwave power, frequency, Q-factor, impedance, admittance, reflection coefficient and noise.

The Organizing Committee invite the submission of papers for inclusion in the proceedings of the conference. Intending authors are asked to submit, as soon as possible and preferably not later than the 15th February 1961, abstracts of not more than 250 words for preliminary consideration.

An exhibition of microwave measuring devices will take place in conjunction with the conference.

SCHOLARSHIPS

THE following scholarships have been awarded by the Council of The Institution for 1960:

RESEARCH SCHOLARSHIPS

Oliver Lodge Scholarship (*tenable for one year*)

P. LINDON — to undertake research into the visco-elastic properties of liquids under alternating shearing stress, using electrical methods

STUDENT SCHOLARSHIPS

Duddell Scholarship (*tenable for two years*)

A. N. LUCAS — to pursue the third and fourth years of the honours-degree course in electrical engineering at Edinburgh University

I.M.E.A. Scholarship (*tenable for one year*)

H. M. BRASH — to pursue the honours-degree course in physics at Edinburgh University

Mervyn J. P. O'Gorman Memorial Fund Scholarship (*tenable for one year*)

H. L. BRADLEY — to pursue the full-time course in preparation for Part III of the Institution Examination at Portsmouth College of Technology

David Hughes Scholarship (*tenable for one year*)

B. L. J. CLEWS — to pursue the final honours-degree course in electrical engineering at Nottingham University

W. B. Esson Scholarship (*tenable for two years*)

D. EVANS — to pursue the honours-degree course in electrical engineering at King's College, University of Durham

Paul Scholarship (*tenable for one year*)

P. R. PARKMAN — to pursue the honours-degree course in engineering at the University of Oxford

Thorrowgood Scholarship (*tenable for one year*)

A. KERR — to pursue the post-Higher National Certificate course at Paisley Technical College

OTHER AWARDS

Mervyn J. P. O'Gorman Memorial Fund Grant

D. J. PAGE — to assist with the expenses of a visit to the Solid-State Section of the Deutsche Akademie der Wissenschaften zu Berlin in connection with his research at the University of Birmingham into the applications of the dielectric diode

BOOKS FOR DISPOSAL

RECENTLY some 300 books, not borrowed since 1948, have been withdrawn from the Lending Library of The Institution.

It has been decided that, before these are disposed of, members should be given the opportunity of acquiring any that they want. A list of the books has been prepared, arranged in subject order, and members who are interested should ask to see a copy.

RETIRED MEMBERS AND THOSE OF LONG STANDING

MEMBERS are reminded of a rule which has been in existence for some years, which enables Corporate members and Associates who have retired from the profession and are still desirous of retaining their membership of The Institution to do so without payment of further subscriptions, or at a reduced subscription, depending on their length of membership. It is left to the members concerned to make application to be brought within the rule. The rule, which does not apply retrospectively, is as set out below:

Any Corporate member or Associate who has reached the age of 60 and has retired from the practice of his profession or business may apply to the Council of The Institution to waive or reduce his future annual subscription, depending on the length of his continuous membership as follows:

25 years	full remission
20–24 years	two-thirds reduction
15–19 years	one-third reduction.

If a retired member of 25 years' standing desires to continue to receive the *Journal*, he can do so on payment of 10s. per annum. Parts A, B and C of the *Proceedings* will also be available to him at the appropriate subscription rates.

A further rule provides that as soon as a member of any class completes 50 years of membership he is not required to pay any further membership subscriptions, regardless of whether he is still in remunerative employment. This rule operates automatically, and the member on qualifying is notified accordingly. If he desires to receive the *Journal* or the *Proceedings*, the arrangement for retired members of 25 years' standing applies.

PRACTICAL PAPERS IN THE *PROCEEDINGS*

THE Council of The Institution welcome the submission, for publication in the *Proceedings*, of short papers dealing with practical problems encountered in the development, manufacture, operation or maintenance of electrical equipment. Such papers are useful to other members facing similar problems. They may be quite short, of any length between, say, 500 and 2500 words. A short practical paper has an obvious attraction for the engineer who is too busy to prepare a full-length one, and it provides information in a form which readers can usually assimilate rapidly.

SUBSCRIPTIONS TO THE PUBLICATIONS OF OTHER ENGINEERING INSTITUTIONS

WE remind members of the reciprocal arrangements whereby they can obtain the technical periodicals of other engineering institutions and societies at the specially reduced rates listed below:

	£	s.	d.
Institution of Civil Engineers:			
Proceedings (single issues 3s. 6d.)	2	0	0
Institution of Mechanical Engineers:			
Chartered Mechanical Engineer	2	2	6

	£	s.	d.
Chartered Mechanical Engineer and separates of *Proceedings* and Automobile Division *Proceedings*	7	5	6
Chartered Mechanical Engineer and separates and bound volumes of *Proceedings* and Automobile Division *Proceedings*	10	4	6
Chartered Mechanical Engineer and bound volumes of *Proceedings* and Automobile Division *Proceedings*	8	18	6
Bound volumes only of Institution *Proceedings* and Automobile Division *Proceedings*	7	5	0
Self-binding case for the copies of *Chartered Mechanical Engineer*		13	0
American Institute of Electrical Engineers:			
Electrical Engineering	2	10	0
Transactions	4	0	0
Communication and Electronics	2	2	0
Application and Industry	2	2	0
Power Apparatus Systems	2	2	0
Associazione Elettrotecnica Italiana:			
L'Elettrotecnica	2	18	0
Alta Frequenza	2	2	0
Dansk Ingeniørforening:			
Ingeniøren	1	5	0
Engineering Institute of Canada:			
The Engineering Journal	1	9	0
Institution of Engineers, India:			
Journal			
Part I (civil and general section)	1	7	0
Part II (mechanical, electrical and general section)	1	7	0
Both the above parts	2	14	0
Single copies		2	3
Institute of Physics and the Physical Society:			
British Journal of Applied Physics	3	0	0
Journal of Scientific Instruments	3	0	0
Both the above publications	6	0	0
Institute of Radio Engineers, America:			
Proceedings	4	17	6
Transactions of the 21 Professional Groups	35	16	6
Transactions of any single Professional Group	3	1	0
Institution of Engineers, Australia:			
Journal	3	3	0
Civil Engineering Transactions	1	4	0
Electrical and Mechanical Engineering Transactions	1	4	0
Both parts	2	8	0
Koninklijk Instituut van Ingenieurs:			
De Ingenieur	2	5	0
New Zealand Institution of Engineers:			
New Zealand Engineering		14	6
Société Belge des Électriciens:			
Bulletin	1	7	6
Société Française des Électriciens:			
Bulletin	3	15	0
South African Institute of Electrical Engineers:			
Transactions	3	0	0
Svenska Teknologföreningen:			
Teknisk Tidskrift	4	0	0
Verband Deutscher Elektrotechniker e.V.:			
Elektrotechnische Zeitschrift edition A (*ETZ-A*)	3	4	6
Elektrotechnische Zeitschrift edition B (*ETZ-B*)	2	4	6
Elektrotechnische Zeitschrift editions A and B	5	4	0
Nachrichtentechnische Zeitschrift (*NTZ*)	2	14	0

Members' subscriptions must be transmitted through the Secretary of The Institution of Electrical Engineers, except those for the publications of The Institution of Mechanical Engineers, which should be sent to the Secretary of that Institution, and those for the *Proceedings* of The Institution of Civil Engineers, which should be sent to one of the following agents:

Sir Isaac Pitman and Sons Ltd.: The Book Centre, North Circular Road, Neasden, London N.W.10; Little Collins Street, Melbourne, Australia; Pitman House, 381–3 Church Street, Toronto, Canada; and 27 Becketts Buildings, President Street, Johannesburg, South Africa. Pitman Publishing Corporation, 2 West 45th Street, New York. A. H. Wheeler and Co.: Hornby Road, Bombay; 11 Clive Street, Calcutta; and 115 Elgin Road, Allahabad.

INFORMAL MEETINGS COMMITTEE

IT is regretted that the name of Mr. W. Ross, M.A., MEMBER, was inadvertently omitted from the list of members of the Informal Meetings Committee on p. 682 of the November 1960 *Journal*.

STUDENTS' QUARTERLY JOURNAL

THE topical subject of magnetohydrodynamic power generation is reviewed in an article by R. Hawley in the December 1960 issue of the *Students' Quarterly Journal*. Other articles deal with durability testing (J. M. Harvey), Yugoslav passages (D. R. Wilson), high-power valve life-testing (H. C. Burford), automatic voltage regulators (A. Wren), cold-cathode diodes (I. R. Smith and D. P. Howson), and linear programming (D. C. Macdonald).

Other features include Section reports, a note on the proposed 1961 social week-end by K. E. Greene, a record of the 1960–61 Graduate and Student Lecture on colour television, book reviews, and other Graduate and Student Section news.

PRESSURE-VESSEL RESEARCH

A SYMPOSIUM on pressure-vessel research towards better design is being arranged by The Institution of Mechanical Engineers and will take place at 1 Birdcage Walk, London S.W.1 on the 18th and 19th January 1961. About 12 papers

will be presented, covering components and experimental research, and design and design codes. The papers will report on stress-analysis investigations, the design and testing of various components, pulsating-pressure tests, fatigue tests, comparisons of various codes, and probable future design requirements.

The symposium will begin at 2.30 p.m. on the 18th and end at 7.30 p.m. on the 19th January, and will consist of four sessions.

A registration form, together with a list of papers to be presented, may be obtained on application to the Secretary of The Institution of Mechanical Engineers. Concessional charges for registration and papers are available to members of our Institution.

CIVILIAN SCHOLARSHIPS

THE War Office is offering a number of civilian scholarships tenable for three years at the Royal Military College of Science, Shrivenham. Successful candidates take courses for the London University degree of B.Sc.(Special) in chemistry, physics or mathematics, or B.Sc.(Eng.). Boys to whom awards are made are expected to join the Scientific Civil Service when they have taken their degree.

A scholarship carries exemption from payment of tuition and examination fees, and the student receives a maintenance allowance of £355 a year. No means test is imposed, and the allowances are not liable to income-tax. Candidates must be under 22 on the 1st October of the year of entry, unless they have completed their National Service, when they must be under 24. The preliminary qualifying examination will be held in February 1961 for entry to the college in October 1961.

Application forms and further information may be obtained from the War Office, C.13(c)3, Room 338, The Adelphi, John Adam Street, London W.C.2.

RADIO SHOW 1961

THE 28th National Radio and Television Exhibition will be held at Earls Court, London, from the 23rd August to 2nd September 1961, with a preview for oversea and other special visitors on the 22nd August.

LARGE-CAPACITY MEMORY TECHNIQUES

THE Information Systems Branch of the United States Office of Naval Research is sponsoring a symposium on large-capacity memory techniques for computing systems, to be held from the 23rd to 25th May 1961 in the Department of the Interior Auditorium, Washington, D.C.

The object of the symposium is to focus attention on new ideas, research and developments which may lead to novel computer memories capable of storing very large amounts of information. Attendance is open to all interested persons, and further information may be obtained from Miss Josephine Leno, Code 430A, Office of Naval Research, Washington 25, D.C., U.S.A.

MECHANICAL RELIABILITY OF COMPUTERS

AN informal discussion on the reliability of mechanical-engineering parts of data-processing systems is being arranged by The Institution of Mechanical Engineers and will take place at 1 Birdcage Walk, London S.W.1, on the 5th January 1961, starting at 10.30 a.m. The three sessions, morning, afternoon and evening, will discuss fundamental problems of kinetics and the production of electronic equipment and allied precision mechanisms.

Registration forms to attend the discussion may be obtained from the Secretary of The Institution of Mechanical Engineers.

News from the Centres

SCOTTISH CENTRE

Activities of the Sub-Centres

AT the opening meeting of the South-East Scotland Sub-Centre in Edinburgh on the 18th October 1960, the retiring Chairman, Mr. D. M. Thornton, inaugurated the new Chairman, Mr. I. S. Fraser. Mr. Fraser thanked Mr. Thornton for his enthusiastic work for The Institution, particularly in the Border area, and presented him with a copy of 'The history of The Institution' as a token of appreciation.

The Sub-Centre's warmest thanks were also given to Mr. G. I. Thomas on his retiral from the Honorary Secretaryship, and to Mr. A. R. S. Robertson on his retiral from the Honorary Treasurership, of the Sub-Centre. Mr. C. M. Beckett has been elected to the office of Honorary Secretary and Treasurer and Mr. R. Callender has been appointed Assistant Honorary Secretary.

In his Chairman's Address, Mr. Fraser gave a fascinating account of the development of Rosyth naval dockyard, with many interesting illustrations of its initial construction; owing to the inherent modesty of the Royal Navy, few of those present were previously aware of the fact that they had such a large and comprehensive engineering organization in their midst.

Paper-insulated cables

In Glasgow, on the 19th October, Mr. W. L. Kidd was similarly inaugurated, as Chairman of the South-West Scotland Sub-Centre, by the retiring Chairman, Mr. J. E. Sayers. In order to avoid a possible surfeit of Chairman's Addresses in Scotland at this time of the year, Mr. Kidd has decided to present his Address at the beginning of the second half of the session, and his inauguration was therefore followed by a formal paper entitled 'A basis for short-circuit ratings for paper-insulated cables up to 11kV' by L. Gosland and R. G. Parr.

Graham Clark Lecture

Once again the South-East Scotland Sub-Centre has been privileged to hear a Graham Clark Lecture. On the 1st November 1960, in Edinburgh, Sir Hugh Beaver presented his Lecture on 'Engineering and civilization' to a Joint Meeting of the Sub-Centre and the East of Scotland Association of The Institution of Civil Engineers.

Sir Hugh invited comments and questions, and the lively discussion that followed showed how much the Lecture had been appreciated. After opening remarks by Mr. F. R. Dinnis, Chairman of the 'Civils', it was noteworthy that the majority of the speakers were of the younger generation, who showed a keen interest in the subject.

Instrumentation and control of reactors

Although the Electronics and Measurement Group of the Scottish Centre was inaugurated only at the beginning of this session, it is, in addition to a normal programme of papers, organizing a symposium on the 'Instrumentation and control of reactors' to be held in Glasgow (at Chesters, Bearsden) on Saturday and Sunday, 25th and 26th March 1961. The symposium will comprise ten papers, referring largely to the Dounreay reactors, ranging from 'Operational experience of the fast reactor' to 'Human-body radiation monitors'.

The organization is being carried out with the collaboration of the United Kingdom Atomic Energy Authority, Development and Engineering Group, Experimental Reactor Establishment. Application forms will be sent to all members of the Scottish Centre and to others who apply (to the Secretary of the Scottish Centre); but, if oversubscribed, priority will be given to members of the Electronics and Measurement Group of the Scottish Centre. E. O. T.

EAST MIDLAND CENTRE

Activities in October 1960

THIS session started off with a full house for the Chairman's Address, when Col. W. E. Gill covered the history and development of the telephone. He kept his audience interested without the use of visual aids, which augurs well for his year of office.

The following meeting was the miniature 'Faraday Lecture' at Peterborough, when Capt. I. R. Finlayson made his début as a speaker by giving an interesting account of the work of H.M. Cable Ships, much of which was taken from his own experience. These District Meetings are attended by about 170 members and visitors, and are received with enthusiasm.

Measuring equipment

One hundred and twenty members will remember the 20th October as the Inaugural Meeting of the Electronics and Control Group, if for nothing else, by the way the Ericsson Telephone Co. entertained them for tea. Col. Gill took the Chair, and Mr. T. B. D. Terroni, Chairman of the Electronics and Communications Section, introduced the work of the new Group. The first Chairman, Dr. J. H. Mitchell, gave a talk, in his own inimitable way, on the development of measuring equipment and the type of training and qualifications required by the personnel who will use these items in the future.

Then to the 27th October, when Col. Gill gave his Chairman's Address before another District Meeting, this time at Spalding.

On the 21st November, Mr. R. Taylor delivered his Address as the first Chairman of the Bedford Sub-Centre at the Inaugural Meeting. O. S. W.

SHEFFIELD SUB-CENTRE

The electrical contractor

THE Sheffield Sub-Centre opened its new session on the 19th October 1960, when the Chairman, Mr. E. J. Lilleker, gave his Address on 'Electrical contracting in commerce and industry'. A record attendance of over 100 was there to hear him, and to many it was a real eye-opener to know, at first hand, what an electrical contractor has to contend with on the average job.

It was made clear from the Address that contractors realize their responsibilities to the public and to the electrical profession, and that they are regarded as the 'shop window' to the man in the street, who judges electrical engineers by the standards of workmanship he sees and the quality of apparatus he uses. The contractor may be bound by specifications sometimes, but, because the finished job will make or mar his reputation, he keeps his weather-eye open for customer appreciation all the time.

Almost as a side-line, we were treated to a fascinating tour (by slides) through an ultra-modern bakery, and to many in the audience the common loaf of bread is no longer common but is the product of a highly complex, electrically controlled flow-line. The tour was meant to be a sample of an electrical contractor's responsibility in every precision factory in the country, but the product of the factory proved a pleasant competitor to the Chairman's intention.

Mr. J. W. Spooner, junior Vice-Chairman, proposed the vote of thanks and welcome to the new Chairman, and Mr. G. L. Mason, senior Vice-Chairman, the vote of thanks to the retiring Chairman, Mr. F. G. Tyack.

Another noteworthy record achieved at this opening meeting was the collection for the Benevolent Fund, which the treasurer, Mr. F. Seddon, announced had exceeded £16—an all-time record so far as he could recollect.

Graduate and Student Section

The Sheffield Graduate and Student Section opened its session on the 12th October 1960, when the new Chairman, Dr. J. Allison, gave his address on 'Millimetre waves'.

The introduction consisted of a historical survey of early attempts to generate electromagnetic waves at millimetre wavelengths. The reasons why initial successes, using spark-excited oscillators, were not exploited were discussed.

Then followed an explanation of the difficulties involved

in producing coherent generators at millimetre wavelengths. The types of valve at present available or being developed and methods of detection and transmission of millimetre waves were described.

A discussion of the applications of millimetre waves formed the second half of the paper. Those included were communication, navigation, radar, thermonuclear-machine studies, astronomy and weather-forecasting.

Finally, some of the elementary physical properties of millimetre waves were demonstrated, at a wavelength of 8mm, using some of the devices described in the lecture.

As at the Sub-Centre, the attendance was above average, and a strong pace has been set for the rest of the session.

J. W. S.

WEST WALES (SWANSEA) SUB-CENTRE

Annual General Meeting

When Mr. J. Harley, Chairman of the Sub-Centre, presided at its Annual General Meeting on the 22nd September 1960, he gave an interesting report on the technical and social activities of the Sub-Centre during the past year.

He mentioned the Report of the Special Advisory Committee to the Council of The Institution, and the summaries of the Institution Council meetings which appeared from time to time in the *Journal*, and urged members to read them to the fullest with the aim of improving the corporate life of The Institution. Attendance at the meeting was fair, but all present were interested to learn from him of the full programme which had been accomplished during the year.

In his report he touched on the membership of the Sub-Centre, which had increased from 253 to 279; the meetings of the Committee; the attendance of members and visitors at ordinary meetings; the dinner-dance attended by distinguished people; the summer meeting; and the collections for the Benevolent Fund.

The report was received with acclamation, and following a discussion on it, a coloured film entitled '120000 kilowatts under the sea' was shown.

Induction of new Chairman

During the meeting of the Sub-Centre Committee held on the 13th October, Mr. Harley vacated the Chair in favour of Mr. J. Nelsey. Mr. Harley thanked the members of the Committee for their support during his year of office. Mr. Nelsey took the Chair and in turn thanked Mr. Harley, on behalf of the Committee, for the work he had done during the past year.

At the ordinary meeting of the Sub-Centre which followed, Mr. Nelsey gave his address on 'Rectifiers, electrons and radiation', which, illustrated by slides and diagrams, was well received.

Annual dinner-dance

On the 21st October 1960, the Sub-Centre's annual dinner-dance was held at the Langland Bay Hotel, Swansea, under the Chairmanship of Mr. Nelsey, who was accompanied by Mrs. Nelsey. Guests and members numbered 94.

The chief guest was Mr. R. P. Tovey, chief accountant of the Steel Company of Wales. In a witty speech, proposing the toast of The Institution, he said that its members were held in high regard throughout industry, and that his contact with electrical engineers had been gradual and started through the use of the telephone and the teleprinter. Touching on the growth of The Institution, he added that he was much impressed with its progress and its present membership approaching 46000.

The response to the toast was made by Mr. C. T. Melling, a Vice-President. He, in another delightful speech, said that while membership of The Institution increased so did its standards, with the result that the young electrical engineer of today had to know a lot. Members had to do a wide variety of jobs, and a fine example of this was to be found in the Steel Company of Wales works in south-west Wales.

Personalities at the annual dinner-dance of the West Wales (Swansea) Sub-Centre on the 21st October 1960

Back row from left to right: Mr. J. S. Gazard, Mr. R. P. Tovey, Mr. C. T. Melling, Mr. J. Nelsey, Mr. I. S. Scott-Maxwell and Mr. S. H. Stock. Front row from left to right: Mrs. R. P. Tovey, Mrs. C. T. Melling, Mrs. J. Nelsey, Mrs. I. S. Scott-Maxwell and Mrs. S. H. Stock

Our guests

Mr. Harley, immediate Past-Chairman of the Sub-Centre, proposed the toast of our guests. Mr. J. S. Gazard, deputy general manager of the Steel Company of Wales (Tinplate Division), replied and said that as a member of a sister Institution he had great admiration for the work of electrical engineers.

Mr. J. H. Groocock, a former Chairman of the Sub-Centre, proposed the toast of our Chairman. In responding, Mr. Nelsey made mention of absent friends.

We were glad to welcome many distinguished visitors and their ladies, and to renew acquaintance with old friends. During the dance which followed, a sum of £17 was collected for the Benevolent Fund. Prizes were generously given by friends of the Sub-Centre. Good fare and good company made an enjoyable evening for all.

A. E.

LONDON REPORT

ORDINARY MEETING

LARGE RADIO TELESCOPES

In the 1956 Kelvin Lecture, Prof. A. C. B. Lovell surveyed radio astronomy from the point of view of the knowledge of the universe that has been gained thereby. The Jodrell Bank and the Mullard Observatory telescopes have since come into being, but comparatively little has been said about them as instruments, and this need was admirably met by Dr. A. Hewish when he gave his lecture on 'The principles and operation of large radio telescopes' at Savoy Place on the 27th October 1960.

Introducing Dr. Hewish, the President referred to him as a member of the team working under Prof. M. Ryle, and it was soon evident that he was no stranger either to his subject or to the art of lecturing. He began by reminding us that the need for large optical telescopes was not to obtain greater resolving power but to collect more light, whereas in radio astronomy the difficulty was to build telescopes with sufficiently large apertures to obtain the necessary resolution.

He quoted the problem of scanning the sun's disc and corona, and this led him on to make one of his chief points, that it is better to design a telescope for a particular problem and to have several such instruments than to build a single general-purpose telescope. The resulting simplification in engineering design may lead to considerable economies. Moreover, many new problems require apertures of 1000 ft or more, which are still impracticable with a conventional parabolic dish.

'Skeleton' aerials

It was natural that he should then spend most of his time on the special investigations under study at the Mullard Observatory, around which several large telescopes have been designed based on the 'cross' principle, first developed by Mills in Australia. He gave a lucid description of the theory behind the operation of these 'skeleton' aerials, whereby two linear arrays at right-angles can be made to have the same resolving power as a complete square, by combining the information obtained from the elements in various ways. By working on a wavelength of the order of one metre, the engineering tolerances were eased and the cylindrical reflectors could be made of a system of stretched wires.

The last part of the lecture was devoted to the principle of aperture synthesis, whereby one of the linear arrays is replaced by a small aerial which is moved to occupy in turn all the positions of a much larger aperture. This technique involves very special problems in the design of receivers of high stability and an elaborate computing programme which has been successfully handled by Edsac II in the Cambridge University Mathematical Laboratory.

Circuit problems

The lively discussion which followed centred on the circuit problems of obtaining the necessary stability and reliability over the long periods of recording, and emphasized the point that the aperture-synthesis technique depends on the constancy of the incoming signals. The question was asked whether anything in the nature of a 'sudden commencement' had ever occurred, and Dr. Hewish pointed out that the last 'super-nova' was some centuries ago but that they 'lived in hope'. This recalled an observation made by Sir Edward Appleton at the meeting in The Hague of the Union Radio Scientifique Internationale that these waves had been travelling for thousands of millions of years and that it was a very fortunate thing that we had built our telescopes just in time to receive them.

In conclusion the President thanked Dr. Hewish for the brilliant way in which he had delivered the lecture and answered the questions. G. M.

JOINT MEETING

AN AUSPICIOUS START

A joint Committee was recently formed by the Royal Aeronautical Society and The Institution to consider ways of fostering, and of stimulating discussion on, aircraft electrical engineering. It was agreed that this could best be accomplished by arranging Joint Meetings of the two organizations in London and by the formation of Joint Groups in the Provinces. It was intended that the meetings should be informal and in the nature of colloquia, so as to ensure wide interest. The inaugural meeting was held at Savoy Place on the 11th November 1960.

The meeting was opened by the President, Sir Hamish MacLaren, who extended a cordial welcome to the R.Ae.S. and invited their President, Dr. E. S. Moult, to preside over the remainder of the proceedings. Dr. Moult briefly sketched the dynamically expanding use of electronics in aircraft, recalling rather wistfully the days when only the ignition required any form of electricity. He then introduced Viscount Caldecote, who proceeded to speak on 'The future of "electrics" and "electronics" used in aircraft and guided missiles'. The lecture is to be published in the *Proceedings*.

Lord Caldecote's introductory remarks stressed the differing requirements for aircraft as opposed to missile electronics. Primarily, aircraft required duplication in their electrical systems, since an equipment failure might mean human fatality, whereas in missiles duplication was not mandatory, the usual results of a failure being loss of money and time. The reliability of a missile composed of some 2000 components was approximately 80–90%, each component requiring an individual reliability of 1 in 10^4. He saw future developments in aeronautic electronics as being concerned

with weight- and space-saving needs, greater safety and higher reliability.

The lecturer described the three microminiaturization techniques now in use or being developed. The flat-component technique involved wafer-like components stacked one on top of the other to form a micromodule which was installed as a single unit. The flat-circuit method entailed moulding the wiring on a flat surface, while in the solid-circuit technique complete circuits were built on a single crystal of semiconducting material.

Control, navigation and communication

The need for landing and take-off monitors was stressed, the speaker suggesting that, by the use of multiple systems, automatic and safer landings could be achieved. He thought it a possibility that Doppler heading-reference aids might be linked to a pictorial display for guidance purposes.

Lord Caldecote went on to speculate on trends in communication, data handling, traffic control, and possible future contributions of electrical techniques to aviation, concluding that, although developments were now proceeding at a rapid rate, there was need for increased practicality, exhaustive pretesting, and a change from manual to more automatic testing of equipment.

In the discussion, Lord Caldecote said that Britain should be spending more money on space research and that we should pool our efforts with those of the United States rather than approach space exploration on a wasteful competitive basis.

Replying to an allegation that component usage was becoming horrifyingly complex, the lecturer agreed that simplicity was a prime virtue of design but said that the involved demands of modern aviation could only be met by complex techniques.

DISTRICT MEETING AT OXFORD

NIMROD

Sixty-two members and friends met at Oxford on the 12th October 1960 to hear Mr. P. Bowles give a lecture about the 7GeV proton synchrotron which is approaching completion at Harwell. It is being built for the Rutherford High Energy Laboratory of the National Institute for Research in Nuclear Science. Mr. Carruthers took the chair.

It was fortunate that Mr. Bowles, who is the project engineer for this massive machine, could lecture at the District Meeting. His ability to make the objects, construction and principles interesting and understandable to 'ordinary' electrical engineers was remarkable.

Starting from first principles, he used slides to illustrate the course of construction, covering civil works, manufacturing problems and techniques, and assembly and theory, commenting so that the project was presented as a logical sequence.

Hungry scientists

It soon became clear that the 7GeV proton synchrotron started with a glorified television tube (46ft long without a screen), which shot a bunch of innocent particles into the maw of the 150ft-diameter 7000ton magnet system at a velocity equal to that produced by a potential of 15MV. Here they were whirled around under the guidance of the 150MVA magnet, receiving a mere 500volt impetus per revolution.

Finally, unable to withstand this treatment any longer, the particles flew out of orbit at an energy equal to that produced by a potential of 7000MV, only to be trapped by a queue of hungry scientists in the adjoining research buildings. Here it will be possible to explore new regions of research into the nature of matter. It was almost an anticlimax to hear that the cost of the project was only £10 million.

The discussion ranged from advanced physics to the problem of operating an overhead crane on a circular track, and Mr. Bowles confirmed how wide was his knowledge of the project.

Mr. D. L. Smart proposed a vote of thanks, which was heartily supported.

Before the lecture Mr. J. L. Taylor, Convener, reported on the meeting of the informal committee concerning the past and present sessional activities. J. L. T.

DISTRICT MEETING AT READING

MINIATURE CIRCUIT-BREAKERS

Development of miniature circuit-breakers for circuit and earth-leakage protection, the subject of a talk given by Mr. J. A. Robbins, was supported by a large audience at the meeting held at Reading on the 17th October 1960. Mr. Forbes Jackson presided.

Mr. Robbins said that, for effective installation protection, circuit-breakers must reliably detect conditions of dangerous sustained overloading. In addition, they must clear short-circuits rapidly and safely. Various forms of time-delay mechanism are in use to achieve this, some of which use a thermal time-delay, while others use a dashpot arrangement.

For the type of application in mind, short-circuit fault currents rarely exceed 1500amp, and the method of testing for short-circuit rating must be such as to ensure that the circuit-breakers under test can clear a sequence of short-circuit faults at their rated breaking capacity; at the conclusion of the sequence they must still remain capable of detecting dangerous conditions of sustained overloading, and at the same time be capable of carrying rated current safely and continuously.

Sealed enclosures

Detailed developments in mechanisms are along the lines of trying to ensure long service life. The adoption of sealed enclosures makes these units virtually tamper-proof.

Latest developments in voltage-operated earth-leakage circuit-breakers are mainly concerned with sealed enclosures for the mechanism and the method of protecting the trip coil against possible damage due to lightning. There have been considerable advances, mainly on the Continent, in

current-operated earth-leakage circuit-breakers. This development has mainly been aimed at achieving relatively high sensitivities without causing nuisance tripping.

A lively discussion followed, during which great interest was shown, not only in the development, but also in the use, of miniature circuit-breakers, particularly in connection with earth-leakage protection. Appreciation for the very able and interesting manner in which the speaker had dealt with his subject and the many questions which had followed was suitably expressed by Mr. E. W. Weaver. R. G. H.

BULLETIN OF THE SECTIONS

MEASUREMENT AND CONTROL

TIME AND INSULATION

WHEN Mr. C. G. Garton gave his Inaugural Address as Chairman of the Section on the 11th October 1960 at Savoy Place, Prof. A. Tustin was unfortunately prevented by illness from taking the Chair; Mr. J. K. Webb, a former Chairman, deputized for him.

The subject, 'Time and insulation', proved to be the decoration of a mathematical skeleton in various interesting guises. If the rate at which a process occurs is proportional to $\exp(-V/kT)$, it can vary very markedly with temperature.

'All things change', said Heraclitus; most things change according to this formula, said Mr. Garton. What appears to be constant is merely changing rather slowly, and Mr. Garton accused the human race of being interested in too limited a range of times. He showed a picture of some limestone which had apparently flowed when given a few million years to do it, and he gave some delightful demonstrations of the properties of a very viscous liquid, a column of which he could bend slowly into a helix but which shattered when it was hurried.

Other demonstrations included a mechanical model of a polar dielectric, which showed a Debye-type loss as its temperature was varied, and both electrical and mechanical forms of an experiment in which a short-circuited capacitor and an apparently unstressed material proved capable of supplying energy. Mr. Garton admitted that the energy might have appeared spontaneously in a few hundred thousand years, but he accelerated the process to a more convenient rate by heating the materials.

Moral of the address

The moral, when these principles are applied to insulation, is that materials should be thought about not in isolation but in relation to the circumstances of their use, and that high temperature is a great enemy. The effect of temperature is particularly unwelcome because the rate-process formula predicts that the better materials will deteriorate proportionally more than others as the temperature is raised.

In thanking Mr. Garton for his lecture, Mr. Webb justly described his style as 'inimitable', and Dr. J. H. Westcott invited Mr. Garton to join the staff at his college so as to bring his gifts as a teacher into more regular use.

Mr. Webb then invited Mr. Garton to occupy the Chair, and the President offered his congratulations to the new Chairman, with good wishes for the session both to him and to the Measurement and Control Section. A. C. L.

RADIOACTIVE-SAMPLE MEASUREMENT

THE title was formidable, and the subject was one made unattractive to many people by the necessity for a knowledge of statistical methods. Yet, in the hands of a skilled lecturer, an entertaining and instructive evening resulted when Mr. E. H. Cooke-Yarborough and Mr. R. C. M. Barnes presented their paper on 'Rapid methods for ascertaining whether the activity of a weak radioactive sample exceeds a predetermined level' at Savoy Place on the 25th October 1960. This paper is reviewed on p. 718.

The paper was accompanied by working demonstrations of the principles of measurement used. At one time even the audience took part, and their egos were suitably flattered by finding that they had the ability to discriminate to a considerable extent between the activity rates of various samples by judging the noise produced through a detector-amplifier-loudspeaker chain.

Originally designed to reduce the time taken by routine hand-monitoring tests, other applications may well present themselves. Instead of monitoring for a fixed time and then looking at the total count activity recorded at the end of the time limit, the authors proposed circuits which would very quickly indicate whether the samples being monitored were well away from tolerance level, either upwards or downwards. Thus the test would only take a full normal monitoring period if the activity was very close to tolerance level.

In the conditions likely to be encountered in the routine monitoring of radioactivity on the hands, this method gives a fivefold saving in time over the simple test procedure.

Applications

Mr. B. C. Corbett outlined the way in which he had similarly applied the authors' principles to integrating circuits with finite time-constants, and Dr. D. Taylor discussed the more general application of the authors' ideas. In particular he wondered whether they could be applied to very-low-level

alpha-activity counting, which might be associated with monitoring the civil nuclear-power stations for burst-slug detection at shut-down.

Other applications that came to his mind were those associated with plant control, where the general problem is to decide whether a plant parameter is outside a predetermined band. Mr. R. D. Trotter also commented on the possible application of the authors' principles to burst-slug detection, this time with the reactors at full power, and also discussed the possible extension of the principles to monitoring the rate of change of activity.

The authors replied to all the points raised, admitting that they had not extended their ideas into rate-of-change measurement, being daunted by the statistical analysis that would be required. It was certainly true that their techniques could be extended to burst-slug detection purposes, particularly if the designer was not restricted to a permanent sample time and could afford to dwell for some time on the more doubtful channel being sampled.

Mr. C. G. Garton, Chairman of the Section, expressed the thanks of all those present to the authors for a pleasant and valuable evening. R. D. T.

UTILIZATION

ELECTRICAL PLANT FOR INDUSTRY

THE meeting at Savoy Place on the 13th October 1960, at which the Inaugural Address of Mr. J. M. Ferguson, the new Chairman of the Section, was read, was distinctive for a number of reasons. It was not only honoured by the attendance of the President, but was also graced by the presence of a number of members' ladies. In addition, it was the first meeting the Section had held in the Lecture Theatre since its reconstruction, and presented an admirable practical opportunity to note and appreciate the many improvements made and amenities provided.

Mr. Ferguson entitled his address 'Developments in electrical plant for industry', and in introducing his subject expressed the view that our standard of living depended on the wealth of our natural resources and the productivity of the workers, and that, as regards this latter factor, we had quite a long way to go in relation to other countries. Increasing productivity is accompanied by a growing demand for energy, the use of which, in its electrical form, has been particularly stimulated owing to the fact that the cost of electrical power over the past few years has increased by only 20% compared with much greater increases in the cost of other fuels.

Automatic-control gear

Discussing electrical drives, he referred to the types of motor available and relative costs, and dealt with the scope of constant-speed and variable-speed drives. In connection with the generation of direct current for motors for traction and mill drives, he said there had been a steady swing from the rotating convertor towards the use of mercury-arc convertors and more recently to silicon and germanium.

He stressed the advantages obtainable from automatic-control gear, and, in referring to the incorporation of high-speed computers for this purpose, felt that before these were widely applied to large industrial plant it would be necessary to have knowledge of the reliability such a system would give and to be quite certain that in each case the increased complexity would bring a certain and adequate reward, a sentiment which was echoed, no doubt, in the minds of many of his audience.

An excellent colour film illustrating many of the practical applications covered by the Address was shown.

On the proposition of Dr. H. G. Taylor, a well deserved vote of thanks was accorded Mr. Ferguson for his very interesting and instructive Address.

Mr. R. A. Marryat voiced the appreciation of the Section for the untiring efforts of the retiring Chairman, Mr. T. E. Houghton, during his term of office, which was endorsed with considerable acclamation. R. H. R.

ELECTRONICS AND COMMUNICATIONS

MICROMINIATURIZATION AND THERMIONIC SCIENCE

ON Wednesday, 21st December 1960, Mr. L. J. Ward will lecture at Savoy Place on 'Microminiaturization'.

Mr. Ward, who was born in 1917, studied electrical engineering at Manchester College of Technology, where he was awarded a college prize in 1935 and a B.Sc.Tech. degree in 1938.

He joined the General Electric Co., Salford, and worked on military and industrial electronics and, in particular, proximity fusing. There followed a short spell at Metropolitan-Vickers on radar. For the last 12 years he has been with English Electric Aviation and has worked on the development of guided missiles. At present he is chief of development and manager of the Luton branch of the Guided Weapons Division.

Research in thermionics

On Monday, 9th January 1961, at Savoy Place, Dr. G. H. Metson will lecture on 'Recent research in thermionics'.

Dr. Metson has spent the whole of his professional career with the Post Office. After some years in field engineering,

where he gained a wide experience in manual and automatic telephone-exchange operation, construction and operation of long-distance cable systems, etc., he turned to research work at Dollis Hill. Since the 1939–45 War, he has specialized in thermionic science and taken particular interest in the fundamental properties of the oxide cathode. He was associated with the development of valves for the first transatlantic telephone cable.

SUPPLY

THE DEVELOPING ENGINEER

MR. J. E. L. Robinson, the incoming Chairman, chose the intriguing title 'The developing engineer' for his Inaugural Address on the 19th October 1960 at Savoy Place. In outlining the theme, three broad facets were presented, and he conveyed thoughts which were highly appreciated by the President, Sir Hamish MacLaren, members and ladies.

Evolution

It is with industrial growth that the number of men practised in the skill required of engineers has become significant. With this development, status within society and responsibility to it have grown. Recently, this social aspect has engaged the attention of several eminent engineers, and many questions have been posed. The solution of some of these should receive more attention in school, and the approach to the humanistic side should commence there and continue into the realms of higher education.

The importance of these problems, not only to engineers but also to the community, is being realized. Progress is being made, but scope for considerable enlightenment remains.

Introspection

In assessing the outlook of the individual engineer and the manner of its development, one cannot escape from the environment of personal experience. The Chairman-Elect sketched the nature of scientific events over the past three decades, and brought out the aspect that during one's earlier years it was doubtful if awareness of the significance of many scientific events was fully developed. However, a philosophy grows and creates an outlook which can be searching, broad and speculative.

Development

Progressive improvement or development in some form engages the attention of all engineers. Apart from the spectacular, there remains pressure on problems associated with the basic materials employed. Mr. Robinson outlined the advances in the properties of magnetic materials, the greater appreciation of dielectrics, and the possibility of employing recognized conductors more efficiently by evolving suitable techniques.

He ventured to suggest that the overhead line may at some future time be outmoded for primary transmission. He questioned whether the circuit-breaker was all that it should be.

Generators, he felt, were near their ultimate form; transformers now came under consideration. Mr. Robinson considered that much which could be classed as Victoriana existed, and the dependence on craftsmanship and the growth of intricacy required study.

The contribution to volume and weight by the magnetic and conducting materials warranted close attention. With cylindrical construction, produced by the continuous winding of a foil conductor and insulation sheet and arranged with suitable stress grading, greater utilization of the materials could be accomplished. The technical advantages were given. It was admitted that such construction was not without difficulties, and the nature of these was mentioned; but the approach tended towards continuous processing, with resultant manufacturing and economic benefits.

It was postulated that, with the growing size of transformer units, ultimately a construction whose electric circuits were completely sealed could be assembled with its associated magnetic circuit after conveyance to site.

In conclusion, Mr. Robinson felt that the immediate future held the possibility of an upward trend in technological development, and, realizing many of his views would not lack opponents, he would welcome, on future occasions, the reaction of the opposition.

Tributes

Dr. J. R. Mortlock, retiring Chairman, called on Mr. D. B. Irving, Vice-Chairman, who formally moved the acceptance of the Address.

Mr. J. E. L. Robinson was inducted into the Chair, and the President, in congratulating him on his accession, advised that he had no intention of delivering a homily but was anxious to homologate the views expressed.

The retiring Chairman received the attention of Mr. D. P. Sayers, a self-styled past-Past-Chairman, who invited Dr. Mortlock to join the company in the nether regions of the Institution hierarchy. In gracious terms, he coupled Mrs. Mortlock with the thanks due to her husband.

Mr. C. H. Flurscheim, Vice-Chairman, in seconding the motion, paid tribute to the work of Dr. Mortlock in helping younger men. He was an author and lecturer, but although his approach was mathematical it was practical. As a consulting engineer he was not averse to crossing technical swords, and as a navigator had performed with a stability characteristic of his bent.

The motion, to which Dr. Mortlock briefly replied, was carried with extremely warm acclamation. F. C.

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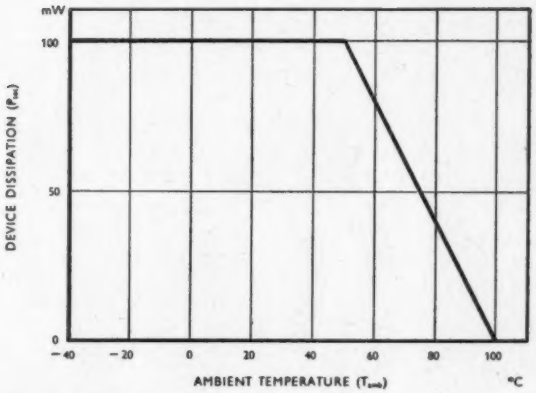

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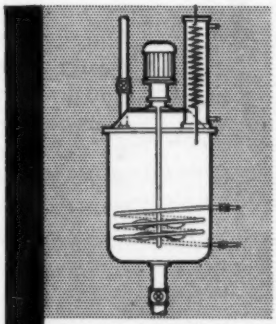

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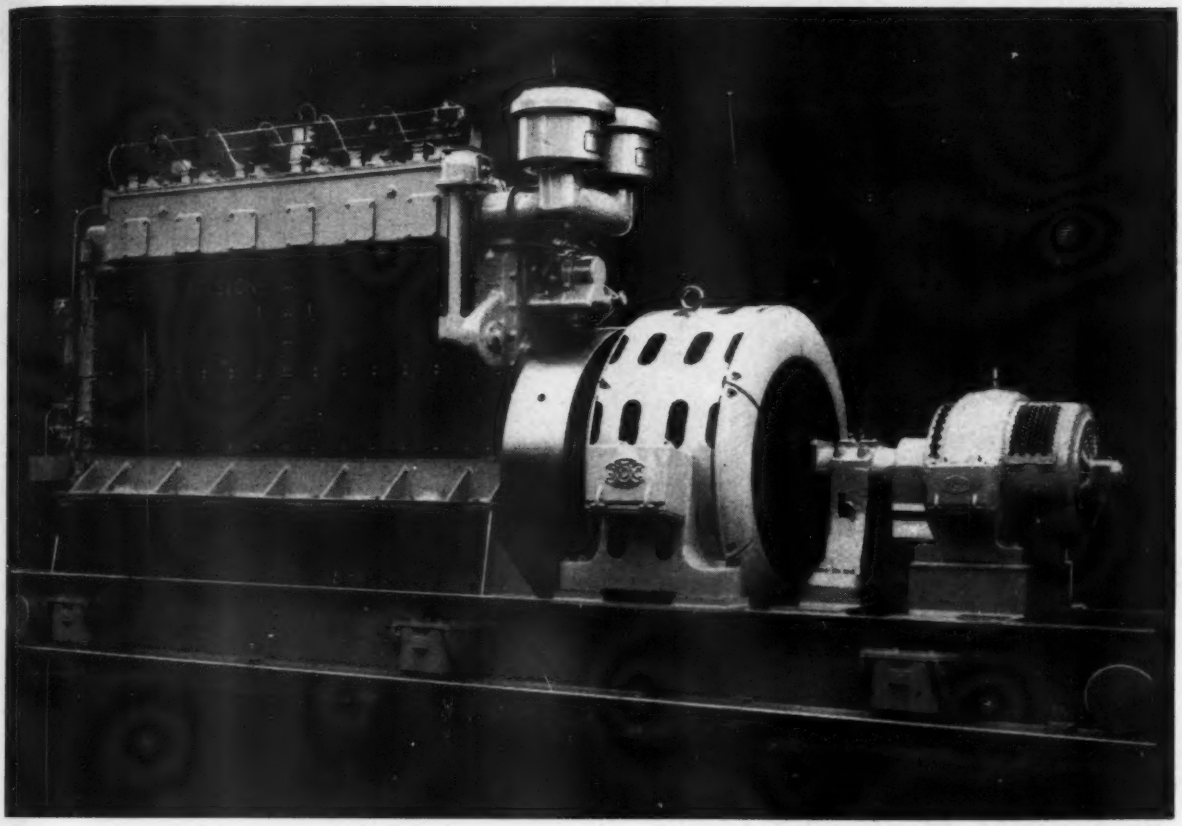

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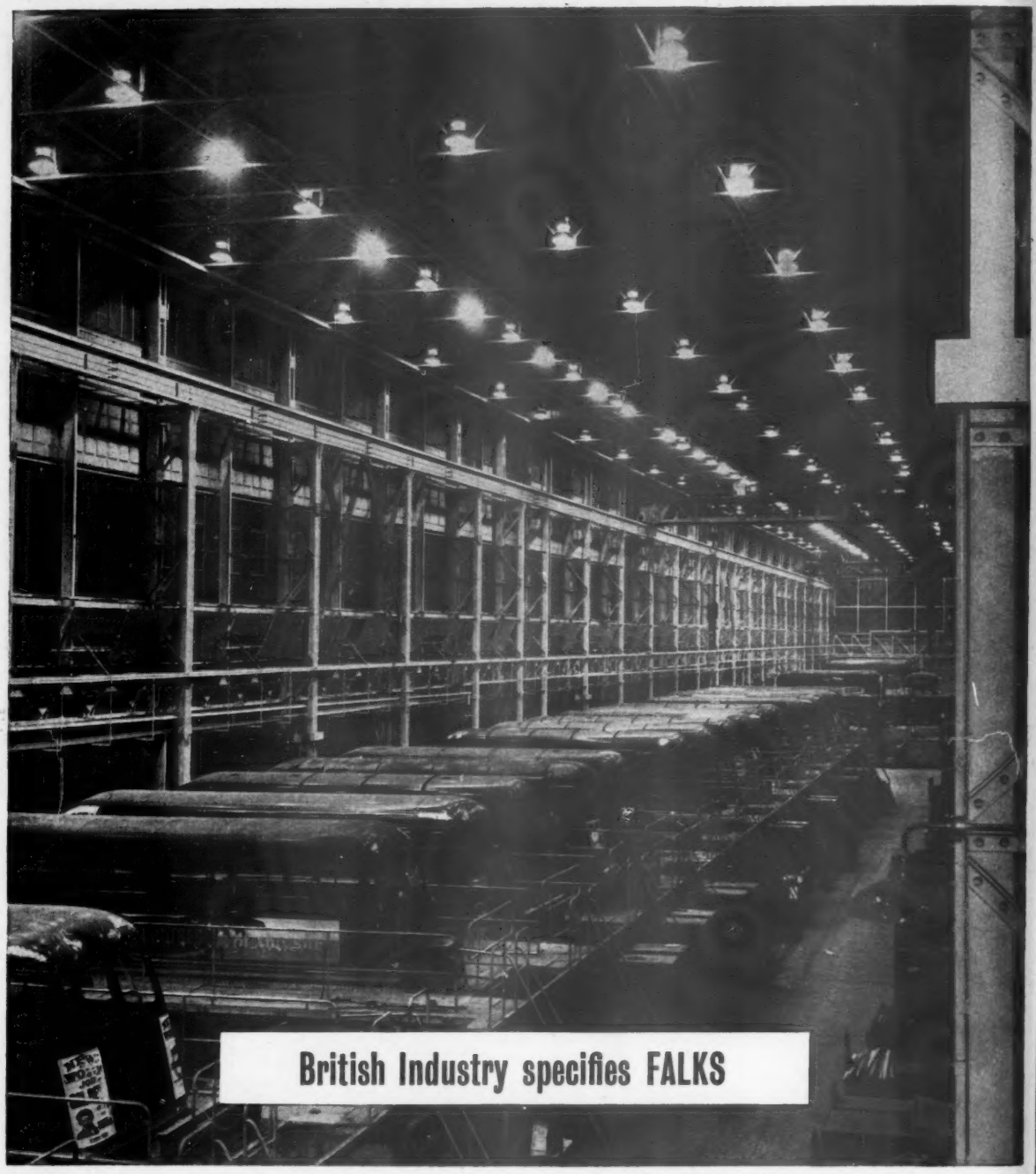

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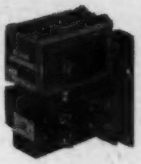

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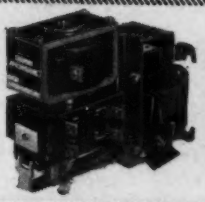

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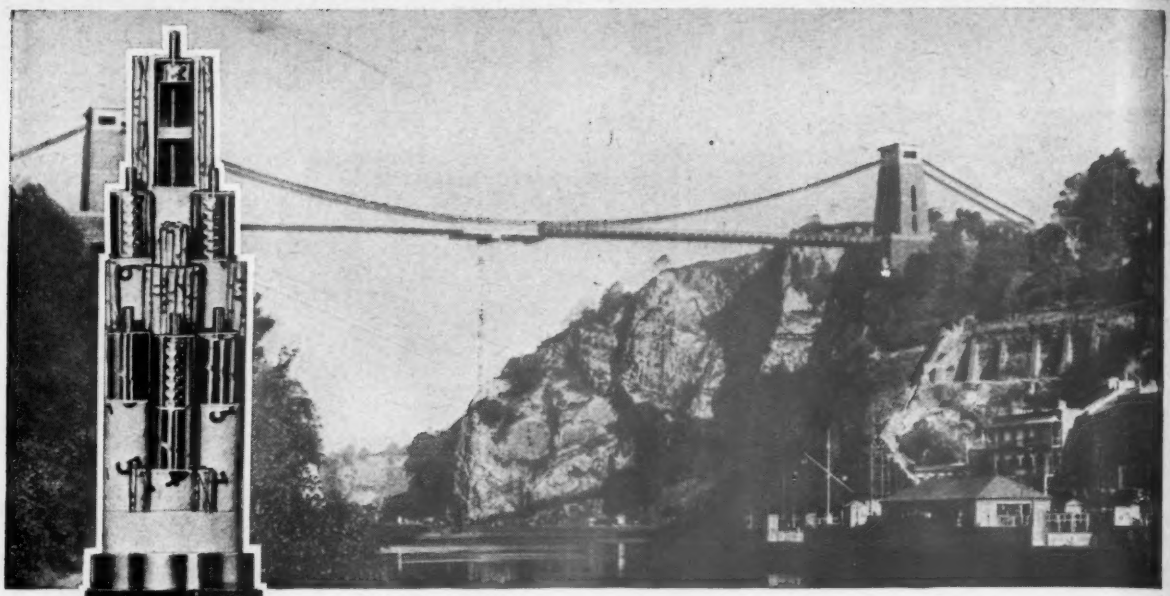

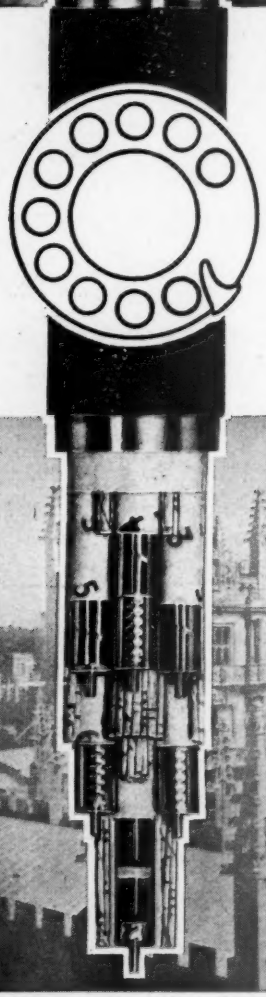

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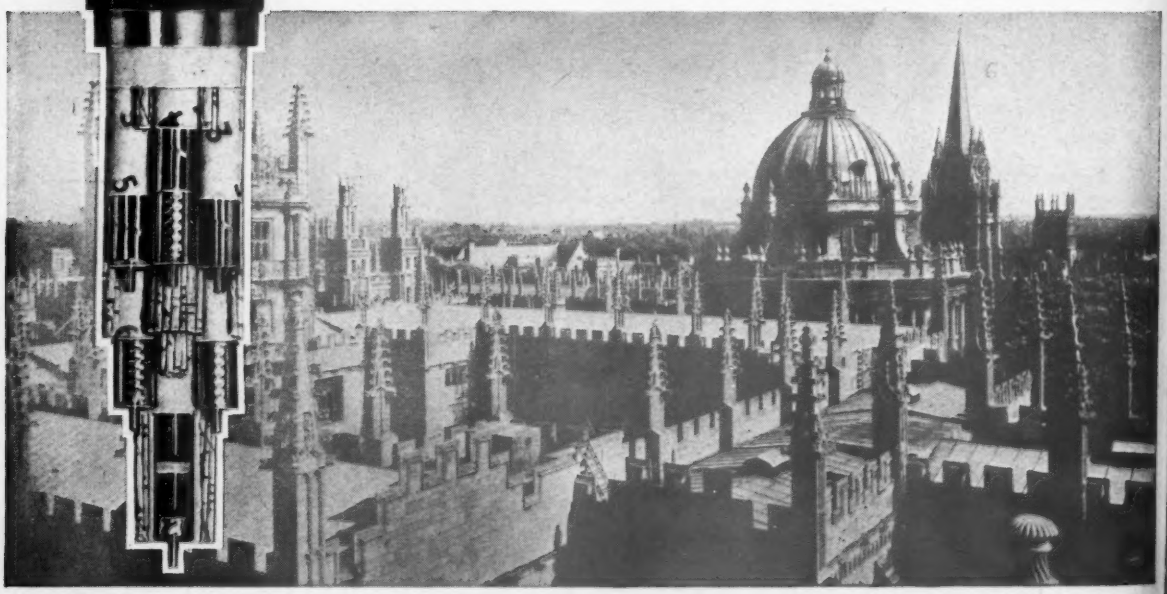

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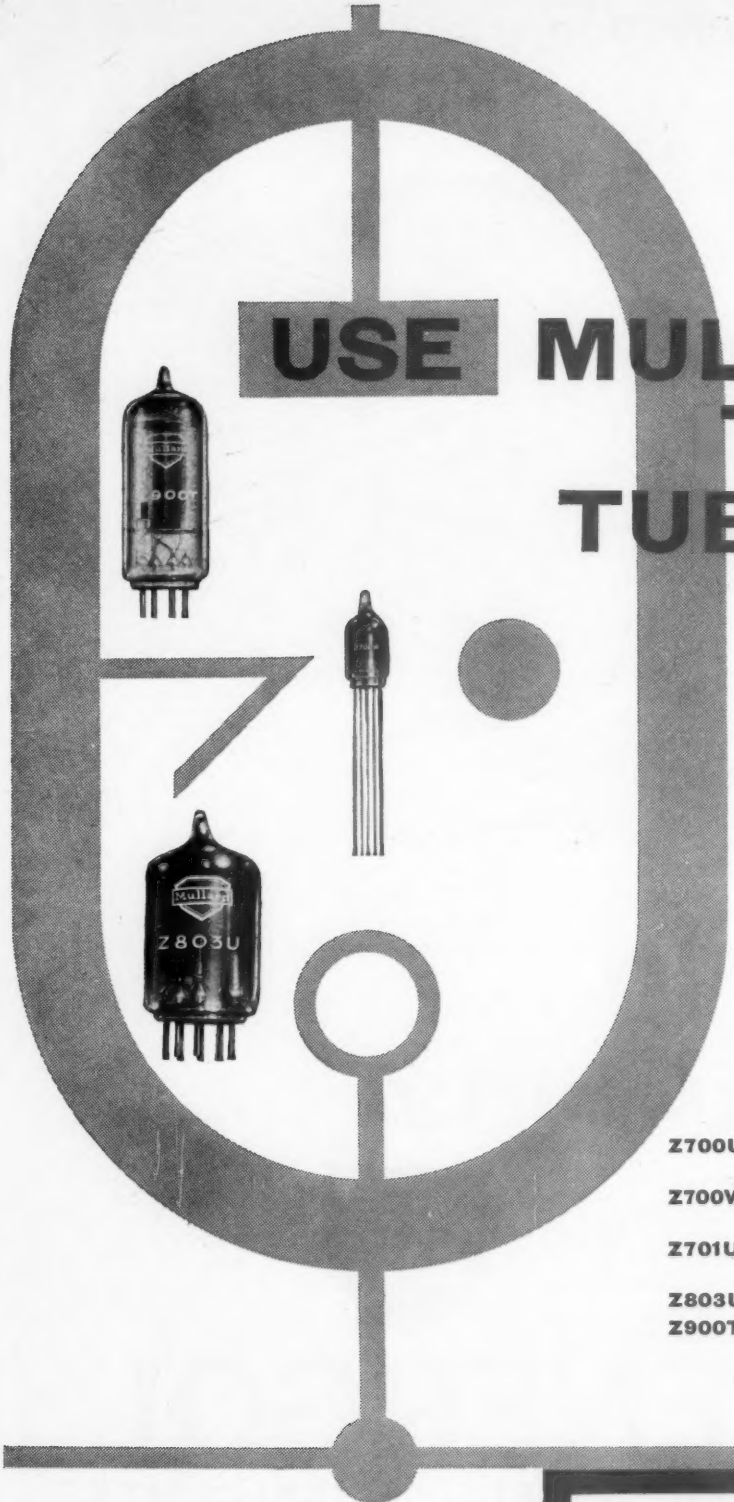

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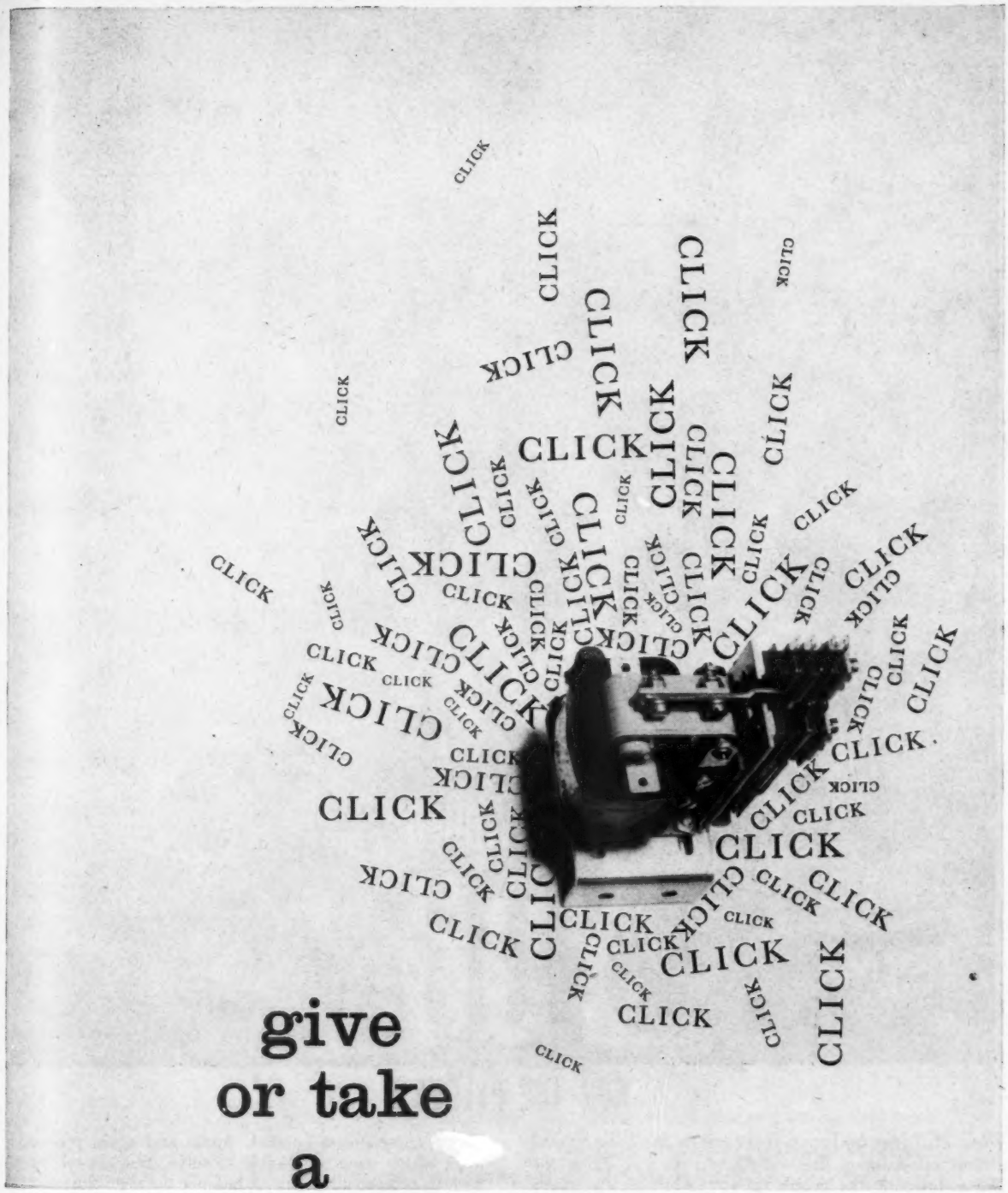

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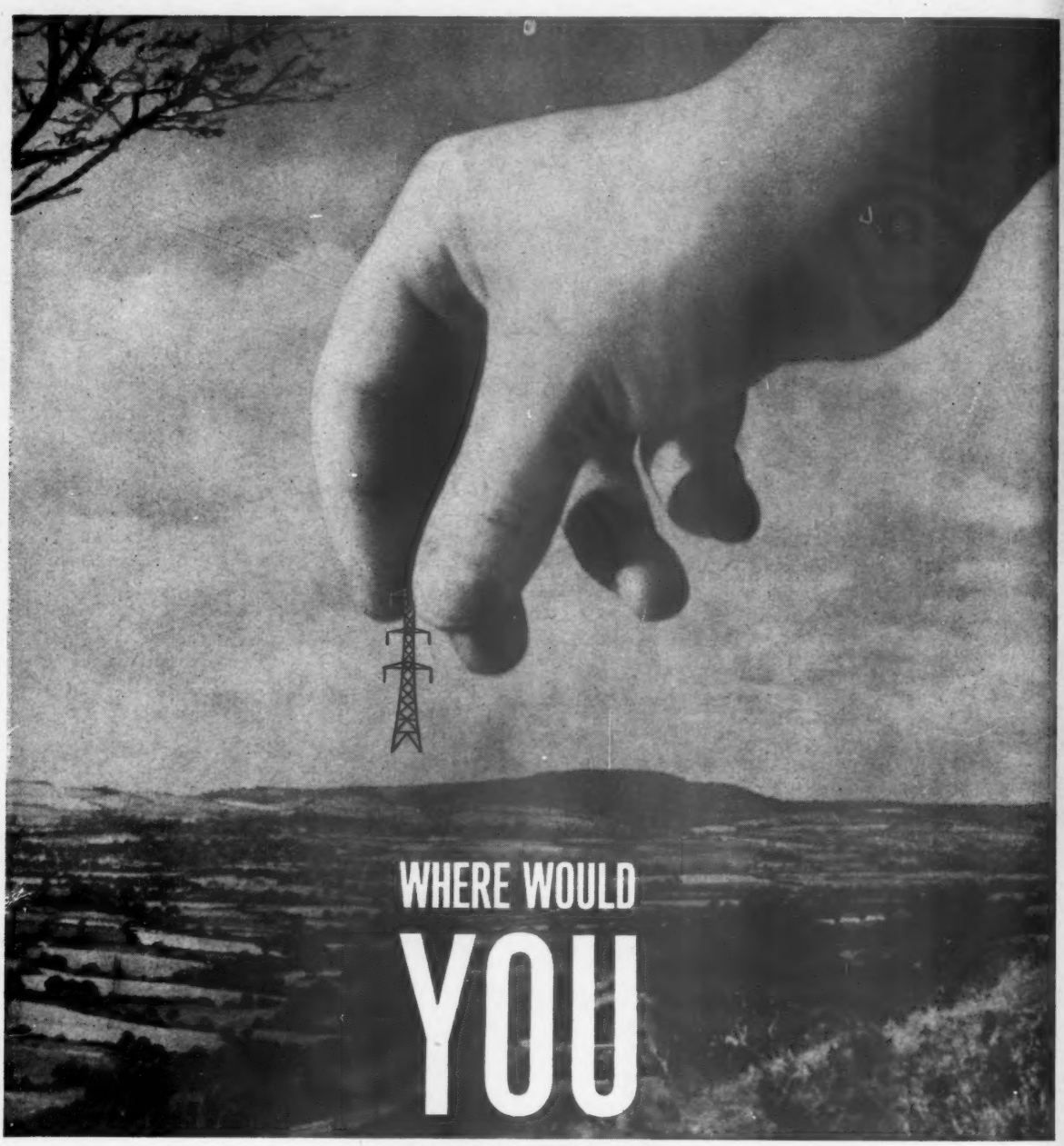

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- **20 to 2000 x variable gain (in 10 stepped ranges)**
- **1 x to 2 x gain variation on each range**
- **Gain accuracy ± 1% (to 2 kc/s), ± 3% (to 10 kc/s)**
- **DC – 40 kc/s (–3 dB) frequency response**

The highest possible gain stability with a unique chopper stabilising circuit
High power output at low source impedance
Optional isolation from ground to minimise ground loop problems

BRIEF SPECIFICATION

Gain Ranges:	20, 30, 50, 70, 100, 200, 300, 500, 700, and 1000 x (2:1 gain variation on each range)
Linearity:	Better than 0·1% to 2 kc/s
Frequency response:	< 3 dB down at 40 kc/s
Zero Drift:	< ± 2 μV for 40 hours when used with regulated mains supply < ± 5 μV change with ± 10% change in mains supply
Equivalent Input Noise:	< 6 μV pk-pk (DC—3 c/s) < 5 μV r.m.s. (DC—750 c/s) < 12 μV r.m.s. (DC—50 kc/s)
DC Output Limits:	± 35 V into loads > 1 kΩ ± 35 mA peak current
Dimensions:	2⅞" x 7⅝" x 14⅝" (7·3 x 20 x 37·2 cms)

Write for full details: **SOLARTRON LABORATORY INSTRUMENTS LTD**

Cox Lane, Chessington, Surrey. Telephone : LOWer Hook 2150
Cables : SOLARTRON CHESSINGTON • Telex : 23842 SOLARTRON T. DIT.
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Germanium or Silicon?

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TYPICAL STANDARD RATINGS

	Max. Current
Germanium, point-contact	30 milliamps
Germanium, gold-bonded	100 milliamps
Silicon, 10kV, potted	500 milliamps
Germanium, stud-mounted	750 milliamps
Silicon, wire-ended	1 amp

	Max. Current
Silicon, stud-mounted	2.3 amp
Silicon, stud-mounted	10 amp
Germanium, fin-mounted	60 amp
Silicon, fin-mounted	150 amp

Standard potted units and stacks from 600 milliamp to 1500 amp.
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Power Rectifier Sales — **Heavy Plant Division** — RUGBY

or

Semiconductor Sales — **Electronic Apparatus Division** — LINCOLN

AEI **Associated Electrical Industries Limited**

A5540

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BRITISH DRIVER-HARRIS

Manufacturers of precision resistors and potentiometers demand resistance wires so fine that they can hardly be seen. Some ask for wire with a high specific resistance. Others require a comparatively low specific resistance but it must remain constant with changing temperatures. Yet others call for wire with both a high and an unchanging resistance.
Wires are required in various tempers and finishes, for example, hard-drawn, annealed, bright, oxidised, enamelled, enamelled and silk-covered—there's no end to the variations needed for different jobs. Fortunately, there's no end either to our ability to meet them.
Superfine wires are produced from ·002 in. (0·05 mm.) downwards in alloys which are famous, Nichrome,* Nichrome* V, Karma* and Advance*. Alloys which offer all the necessary resistance properties. Finishes which meet all requirements. It's not surprising, perhaps, that our reputation in the superfine wire field is unique.

Nichrome* & Nichrome* V Nichrome* (65/15 type nickel-chromium-iron) and Nichrome* V (80/20 type nickel-chromium) are the alloys most suitable where a high resistance is necessary and where the change in resistance due to temperature does not hinder satisfactory performance.

Karma* This is essentially a modified 80/20 nickel-chromium alloy, developed especially for the electronics industry, which combines a high specific resistance with a low temperature coefficient.

Advance* Wires of this 60/40 copper-nickel alloy have a low temperature coefficient and a fairly high specific resistance—important properties in precision resistors which must have constant resistance over a wide temperature range.

For further information write for Data Sheet No. 1, a 4-page booklet containing comprehensive technical information.

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NICHROME REGD TRADE MARK

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Cheadle Heath, Stockport, Cheshire

STC

WORLD-WIDE EXPERIENCE

STC are supplying main line mi wave telephone systems to countries and have already supp systems with a capacity of ove million telephone circuit miles, 8 television channel miles and an e capacity of standby equipment.

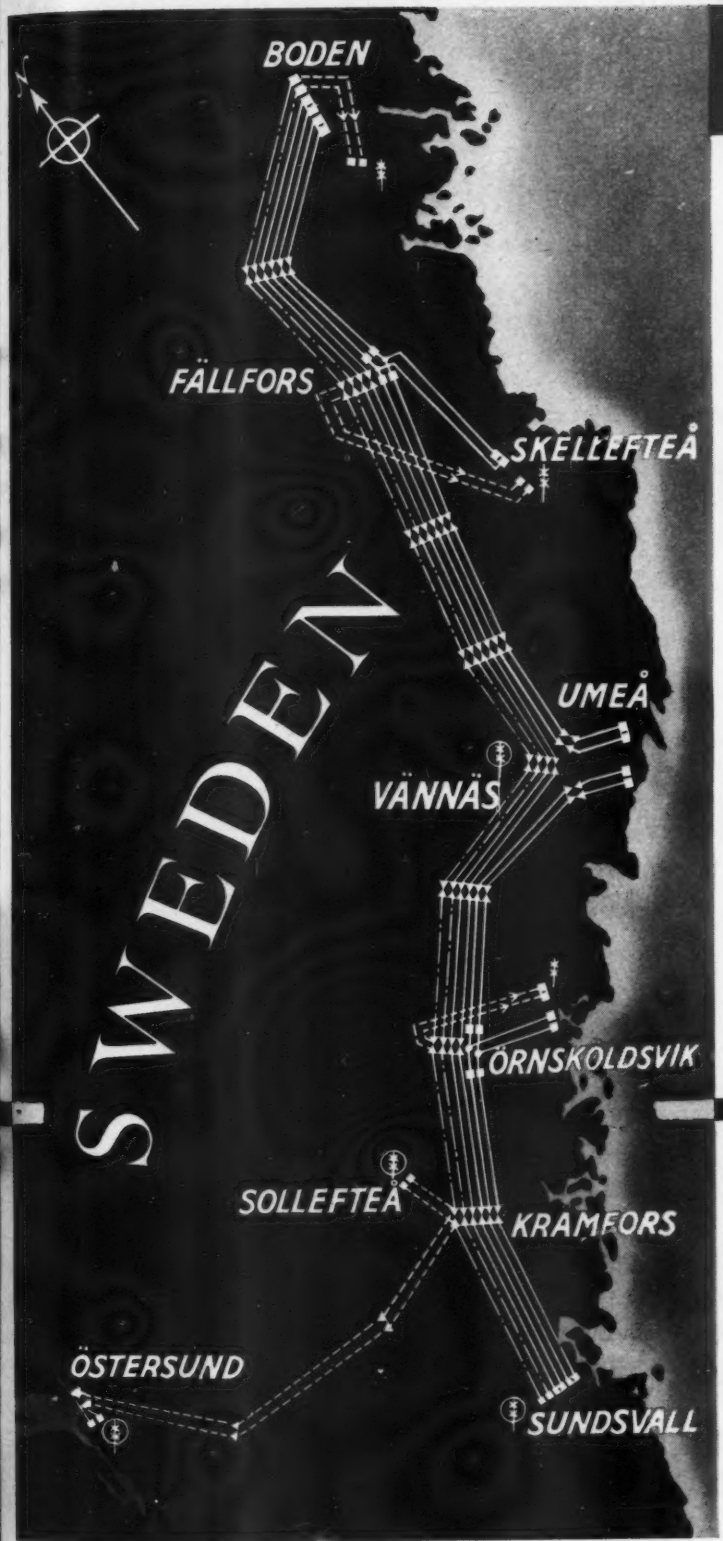
SWEDISH MICROWAVE SYSTEM

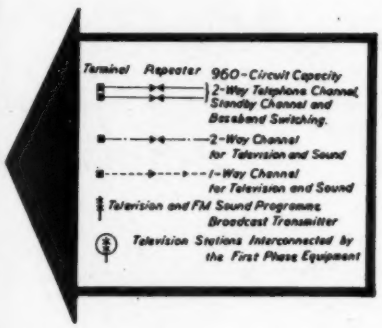
STC have a contract to supply and install a 4000 Mc/s multi-channel telephone and television network for the Royal Board of Swedish Telecommunications. Including spur routes it covers an approximate total of 670 miles (1100 km.)

The network will join the large communications network of the south of Sweden to that of the north by connecting the Stockholm-Sundsvall coaxial system with Boden where a coaxial system extends to Kiruna.

Thus STC coaxial and microwave equipment will be in service over nearly the whole route from Malmo in the south to Kiruna within the Arctic Circle; a distance of over 1600 km (1000 miles). Working and standby radio channels will be equipped with automatic baseband switching equipment to ensure interruption-free service. Each radio channel will have a traffic capacity of 960 telephone circuits, or one television circuit carrying both picture and sound transmission.

The first phase of the television project was completed in May 1960.

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2-Way Channel for Television and Sound
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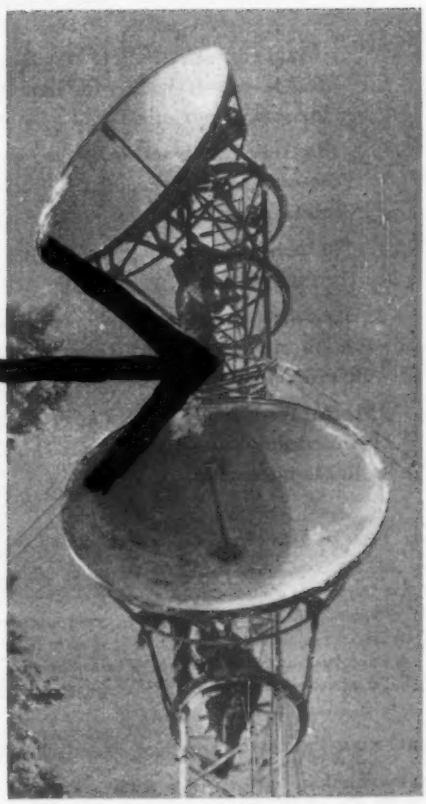

ELECTRONIC SYSTEMS GROUP

Standard Telephones and Cables Limited

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TRANSMISSION DIVISION: NORTH WOOLWICH · LONDON · E16

DE LAVAL CENTRIFUGAL

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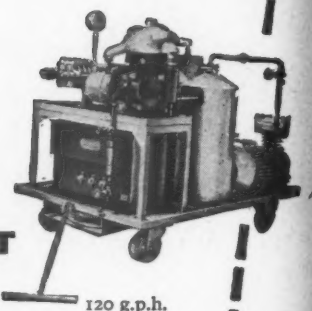

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A wide range of Stationary, Portable and Roadworthy Portable Units with capacities from 10—1200 g.p.h.

Specially designed high-efficiency equipments that ensure:—

Maximum di-electric strengths, well above B.S.S. requirements for new oils, which are retained for longer periods.

Maximum extraction of free and dissolved moisture, air and solids, including colloidal carbon.

No back pressures or fall-off in throughput capacity.

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800 g.p.h.

1200 g.p.h.

These De Laval equipments are now widely employed for:—

1 De-hydration and de-aeration of new oil when filling new transformers at site.
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Smee's DL 481

STYLE	TYPE No.	TYPICAL ZENER VOLTAGE (V_Z)		D.C. WATTS	NOMINAL TEMPERATURE COEFFICIENT % / °C
		D.C. Values at 25% of D.C. Watts	At 10mA		
Miniature	MEZ3.9	3.9	10	125	—.04
Available	MEZ4.7	4.7	14	105	0
in style	MEZ5.6	5.6	12	90	+.03
MEZ, 500mW	MEZ6.8	6.8	9	73	+.05
	MEZ8.2	8.2	8	60	+.06
	MEZ10	10	3.5	50	+.07
	MEZ12	12	3.5	42	+.075
	MEZ15	15	6	33	+.08
	MEZ18	18	12	28	+.085
	MEZ22	22	20	23	+.09
	MEZ27	27	35	18	+.095
1 Watt	1Z3.9	3.9	3.0	250	—.04
Available	1Z4.7	4.7	6.5	205	0
in style	1Z5.6	5.6	5.5	175	+.03
1Z and	1Z6.8	6.8	1.8	150	+.05
1EZ.	1Z8.2	8.2	1.7	120	+.06
	1Z10	10	1.5	100	+.07
	1Z12	12	2.4	80	+.075
	1Z15	15	5.4	65	+.08
	1Z18	18	11	55	+.085
	1Z22	22	18	45	+.09
	1Z27	27	28	35	+.095

ZENER DIODES

IMMEDIATE DELIVERY FOR YOUR PROTOTYPES

STYLE	TYPE No.	TYPICAL ZENER VOLTAGE (V_Z)		D.C. WATTS	NOMINAL TEMPERATURE COEFFICIENT % / °C
		D.C. Values at 25% of D.C. Watts	At 10mA		
10 Watt	10Z3.9	3.9	.64	2500	—.04
Available	10Z4.7	4.7	.68	2000	0
in style	10Z5.6	5.6	.5	1750	+.03
10Z and	10Z6.8	6.8	.2	1500	+.05
1EZ	10Z8.2	8.2	.22	1250	+.06
	10Z10	10	.26	1000	+.07
	10Z12	12	.38	850	+.075
	10Z15	15	1.7	650	+.08
	10Z18	18	3	550	+.085
	10Z22	22	3	450	+.09
	10Z27	27	4.5	360	+.095

PLEASE NOTE WHEN ORDERING

1. Voltage tolerance can be supplied to 10% or 5%. Add suffix, T10 or T5 to the type number corresponding to your requirements.
2. The listed RETMA voltages are 'preferred', the intermediate values are available on request.
3. For the tri-sealed series specify by adding letter 'E'. i.e. MEZ, 1EZ, 10EZ.

INTERNATIONAL RECTIFIER COMPANY

(GREAT BRITAIN) LIMITED · OXTED · SURREY · Oxted 3215

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ge uminium rolling mill in Europe

This 8,000 horse-power 144-inch mill, first stage in a 'hot line' one third of a mile long, is the centrepiece of the latest expansion of the continuous strip mill at Rogerstone, Monmouthshire. New equipment and modernisation at a cost of over £7 million makes Rogerstone the largest aluminium rolling mill in Europe, with a nominal capacity of 70,000 tons of sheet and strip products a year, plus a substantial extra capacity for hot-rolled coil and plate.

It demonstrates the determination of Alcan Industries – the new name of Northern Aluminium Company – to maintain their position as leading suppliers of aluminium products to British industry.

Aluminium alloy plate over eleven feet wide can be produced by this big new mill, compared with the maximum width previously available of about seven feet, and this wide plate offers the designer more scope and can save time and money in construction.

This mill thus complements the other facilities at Rogerstone for production of high-quality, flat, accurately-sawn plate: a 4,000 ton stretcher and special plate saw.

Leadership in equipment is backed by long experience in the application of aluminium, including joining methods. If you use, or might well use, aluminium, for expert advice get in touch with your nearest Alcan Industries (formerly Northern Aluminium) office.

E IMITED

This new name identifies the company more clearly as a member of the Aluminium Limited of Canada enterprise, comprising some fifty companies in all parts of the world. Emphasis is thereby laid on the advantages that the company and its customers enjoy in being able to avail themselves of the Group's extensive research and development resources, and its great fund of experience in the smelting, manufacture and application of aluminium.

ALCAN

A member of the
ALUMINIUM LIMITED OF CANADA
Group of companies

TBW/718

We are proud that our output of capacitors includes precision types made to a wide range of working voltages and close tolerance capacitance values. But we are equally proud that we make others best suited to more general, run-of-the mill applications. And we are proudest of all that every capacitor we make is competitively priced and upholds the unmatched T.M.C. reputation for reliability. We invite you to put them to the test.

TMC

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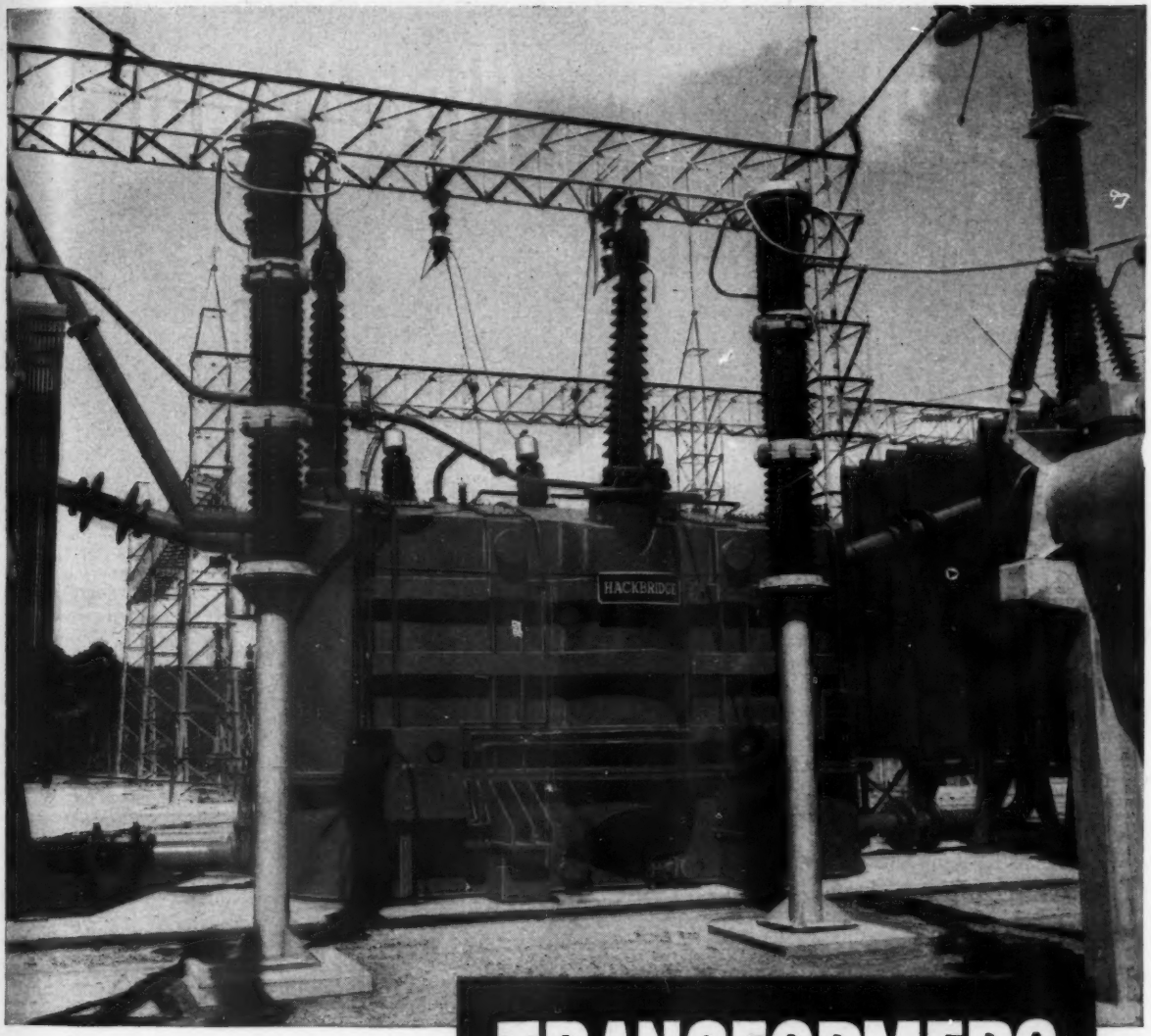
Telephone: Orpington 26611



One of three 100 MVA 220/110 KV Hackbridge transformers installed at the Chapel Street substation, Hobart, Tasmania Hydro Electric Commission.

TRANSFORMERS *BY* HACKBRIDGE

HACKBRIDGE AND HEWITTIC ELECTRIC CO., LIMITED
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Nine- and six-way conduits being laid at the junction of Oxford Street and Portman Street, London W.1.

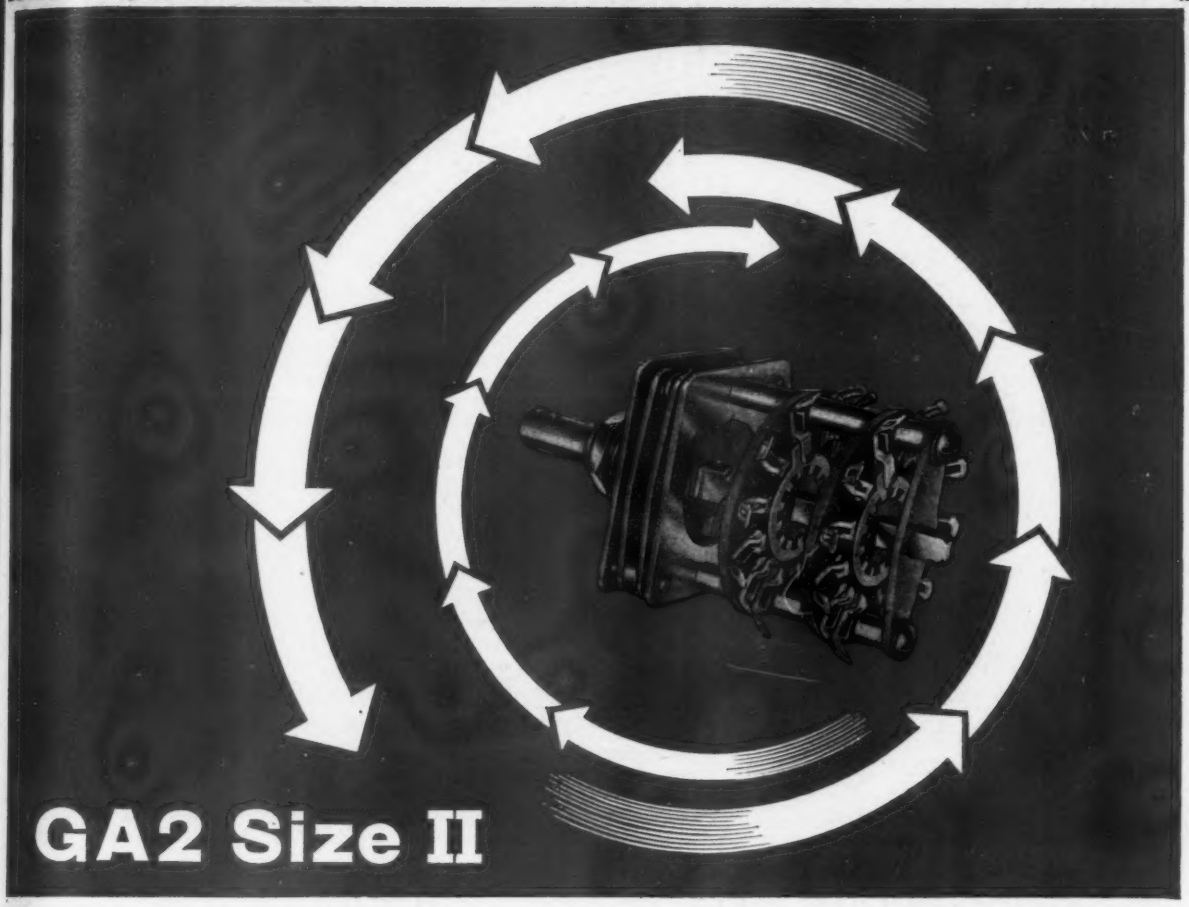
serve . . . the West End well

Only **glazed vitrified clay conduits** can guarantee the degree of protection demanded by the authorities for the permanent security of our tele-communications.
The importance of using **glazed vitrified clay conduits** is widely accepted to-day, especially in our cities where the flow of traffic must be disturbed to the minimum and where the heavy cost of re-excavation must be avoided.
Experience has proved that there is no adequate substitute for **glazed vitrified clay conduits.**

For information write to The Secretary

NATIONAL SALT GLAZED PIPE MANUFACTURERS' ASSOCIATION
Hanover Court, Hanover Square, LONDON, W.1.
Telephone MAYfair 0364.

GLAZED VITRIFIED CONDUITS



multi-bank ROTARY SWITCH

TYPE APPROVED TO DEF. 5154

A miniature switch with roller-click mechanism providing all the facilities offered by the larger types of switch in current use

Specification: Improved techniques enable 22 fully insulated contacts to be used on each wafer and each contact is rated at the full 250V a.c. The switching combinations are therefore increased. The GA2 size II switch has full Joint Service approval, Certificate Nos. 1116 and 1201.

Switch assemblies up to 8" in length (approximately 15 wafers) are normal practice, but considerably longer assemblies, with extra supports, are entirely satisfactory.

The contacts on this sturdy little switch are held in position by the unique "Wedgelock" rivet, while the roller click indexing mechanism confers the benefit of assured indexing accuracy throughout a long working life.

Application: This switch is especially suitable for all applications in communications and is recommended for Ministry equipment, particularly where lightness and reliable performance under arduous conditions is required. It makes an immense contribution to miniaturisation with no loss of efficiency.

Customer service for prototype switches:

To avoid time wasted in assembly of prototype switches from individual parts, Plessey offer a GA2 size II switch kit enabling at least 50 switches to be assembled rapidly and easily—using unit parts—to production standards by relatively unskilled labour. A simple order chart positively identifies the required switch combination for quantity production.

To appreciate fully its capabilities and applications, please write for leaflet No. 140.

Plessey

Components Group, Industrial/Electronic Component Sales

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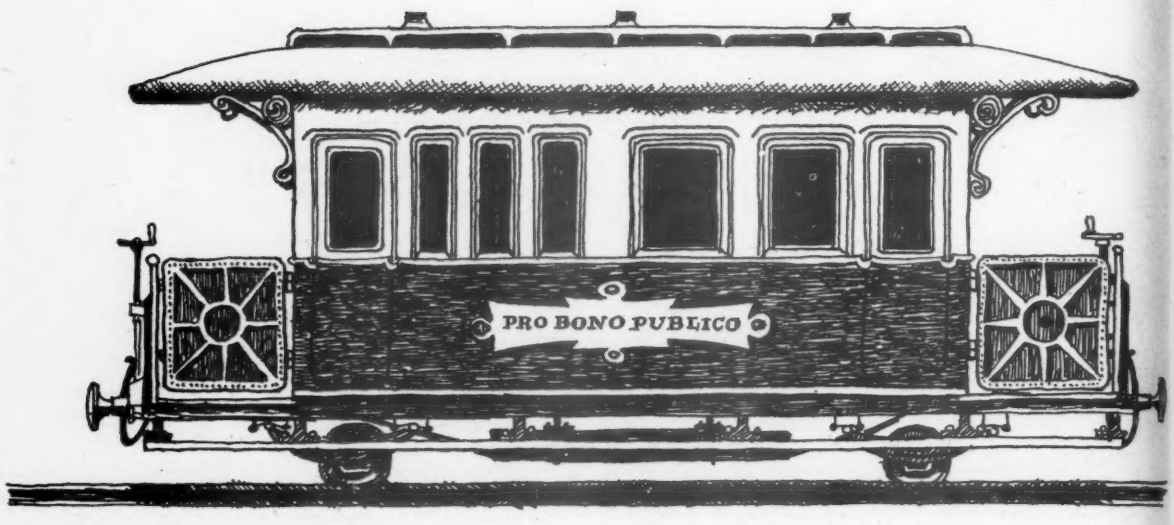
IEC2B

PULLIN'S PUZZLE No. 9



"I really am going to complain about this train service: I shall write a letter to The Times," said a rather impatient friend of mine the other day. "The company claims it is giving us a 10-minute service, so my waiting times should average 5 minutes: some should be longer, but *some* should be shorter. Yet not once this week have I waited less than 5 minutes".

Would he be justified in complaining?

(The occasion of his outburst was in fact the third day of the week)

This is Pullin's Puzzle Number 9. It is designed to entertain those who like trains and those who dislike commuting — in other words, nearly everybody.

There will, as usual, be a prize of 100 cigarettes for the first correct solution to arrive in the post.

The answer to last month's problem was: There are actually 72 solutions, of which the following is typical:—

Specimen	Baking Temp. θ	Time t	Quenching Temp. φ
A	1	1	1
A	2	3	2
A	3	2	3
B	1	2	2
B	2	1	3
B	3	3	1
C	1	3	3
C	2	2	1
C	3	1	2

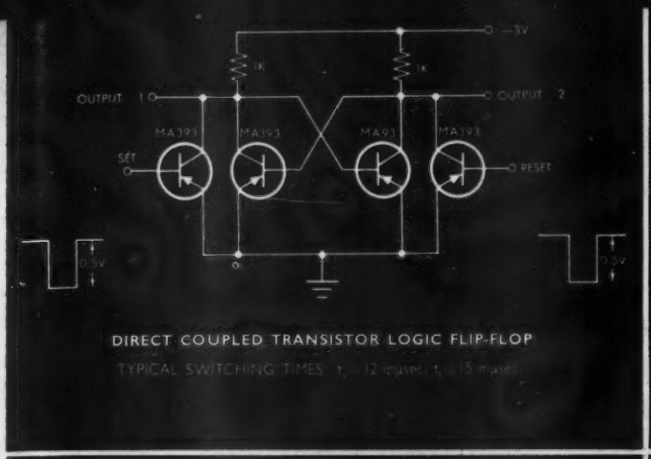
where, for example, the last row stands for-
C θ_3 t_1 φ_2

A second, and perhaps more illuminating way of displaying the solutions is as follows:

BAKING TEMP. \ TIME	t_1	t_2	t_3
θ_1	A φ_1	B φ_2	C φ_3
θ_2	B φ_3	C φ_1	A φ_2
θ_3	C φ_2	A φ_3	B φ_1

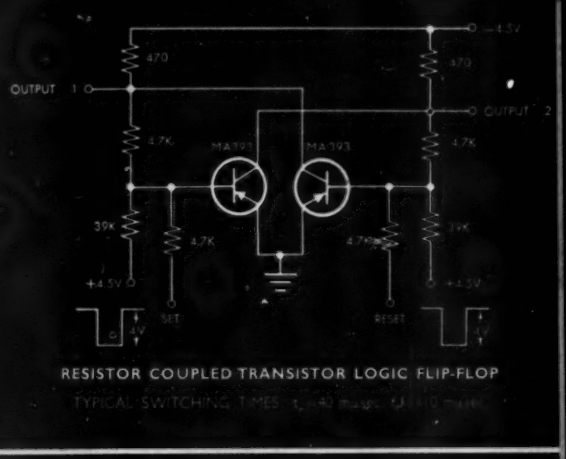
The fact that, for example, the three A's occur one in each row shows that each θ value is represented among the A's; etc. The fact that each square has only one letter shows that any (θ, t) combination occurs once only; etc.

M-I-P
MEASURING INSTRUMENTS (PULLIN) LIMITED
ELECTRIN WORKS, WINCHESTER STREET, LONDON, W.3. ACOrn 4651 & 8801
London Showrooms: Electrin House, 93-97 New Cavendish Street, London, W.1. LANgham 4551-6



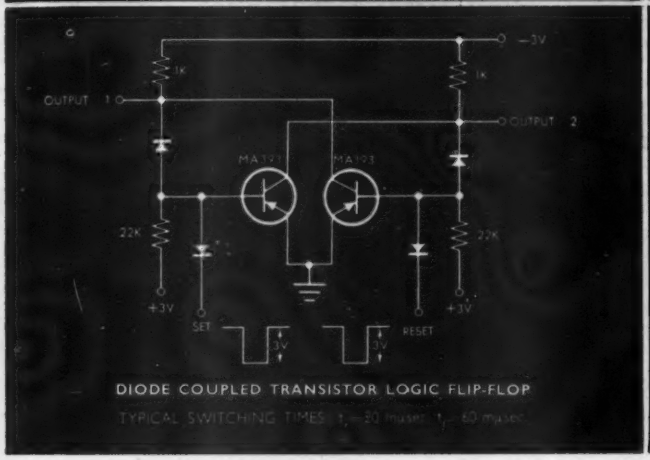
DIRECT COUPLED TRANSISTOR LOGIC FLIP-FLOP

TYPICAL SWITCHING TIMES t_r = 12 mμsec t_f = 15 mμsec



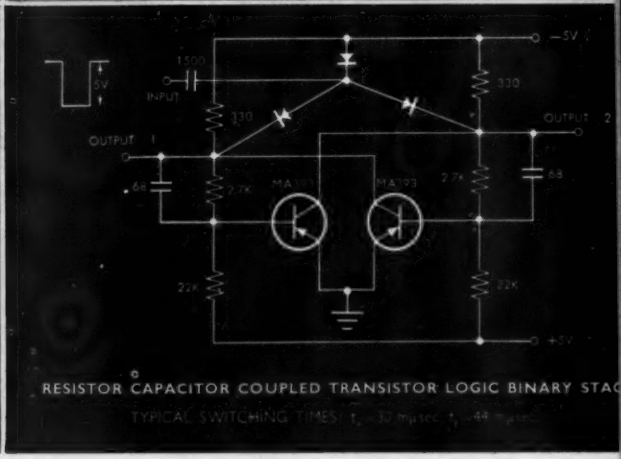
RESISTOR COUPLED TRANSISTOR LOGIC FLIP-FLOP

TYPICAL SWITCHING TIMES t_r = 40 mμsec t_f = 110 mμsec



DIODE COUPLED TRANSISTOR LOGIC FLIP-FLOP

TYPICAL SWITCHING TIMES t_r = 20 mμsec t_f = 60 mμsec



RESISTOR CAPACITOR COUPLED TRANSISTOR LOGIC BINARY STAG

TYPICAL SWITCHING TIMES t_r = 30 mμsec t_f = 44 mμsec

SEMICONDUCTORS MAT TRANSISTORS are UNIVERSALLY APPLICABLE to all Logic Circuits up to 5 Mc/s

high frequency performance . . . at medium frequency prices

The Semiconductors Micro Alloy Transistor (MAT) has proved its complete reliability in millions of operating hours in every type of computer logic circuit up to 5 Mc/s. It combines all the advantages of high frequency performance with low price. The MAT is easily designed into any logic circuit and offers the designer these important advantages:

- High beta
- High speed
- Low saturation voltage
- High V_{EB} rating
- Low I_{CO}
- Low hole-storage time

Semiconductors Limited

For data sheets write to:
Cheney Manor, Swindon, Wiltshire
Telephone: SWINDON 6421

One of the **Plessey** Group of Companies

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. . . . time 0600 hours, visibility 1½ miles, wind N.W. force 8 increasing . . . everything depends on the ship . . . her components must be able to combat the most adverse conditions . . . that's why she's fitted throughout with Mersey toughest-of-all electric cables.

Mersey have been making Ship Wiring cables of maximum reliability at economic prices for many years. And their range is comprehensive; insulated with varnished Cambric or rubber—Butyl or natural—lead covered and armoured, or made to meet a specific requirement. They all comply with the appropriate British Standard Specification and Lloyd's Register for Shipping. Get in touch today, there's a Depot supplying the main Shipbuilding centres throughout Great Britain.

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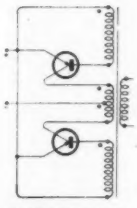
Electrical Division.

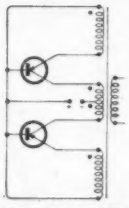
MERSEY CABLE WORKS LIMITED • LIVERPOOL 20 • TELEPHONE BOOTLE 4111

Avel Toroids

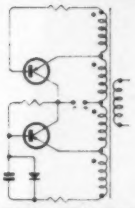
for semi conductor circuits



COMMON BASE



COMMON EMITTER



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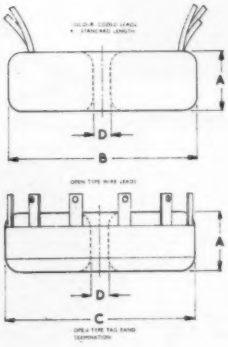
T/5B6/300/2T ..	5–15
T/25C6/300/2T ..	15–50
T/3B12/300/2T ..	2–5
T/5B12/300/2T ..	5–15
T/5AC12/300/2T ..	15–45
T/25C12/300/2T ..	45–60
T/3B24/300/2T ..	2–5
T/5B24/300/2T ..	5–15
T/5AC24/300/2T ..	15–45
T/25C24/300/2T ..	45–75
T/6AD24/300/2T ..	75–120
T/26D24/300/2T ..	120–150



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15-45	1¼	2	2¼	0 BA ,,
45-75	1¾	2	2¼	0 BA ,,
75-120	1¼	2½	2¾	0 BA ,,
120-150	1¾	2½	2¾	0 BA ,,

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Type	5B6	25C6	5B12	5AC12	25C12	5B24	5AC24	25C24
Input, Volts ..	6	6	12	12	12	24	24	24
Max. Watts ..	15	45	15	45	75	15	45	75
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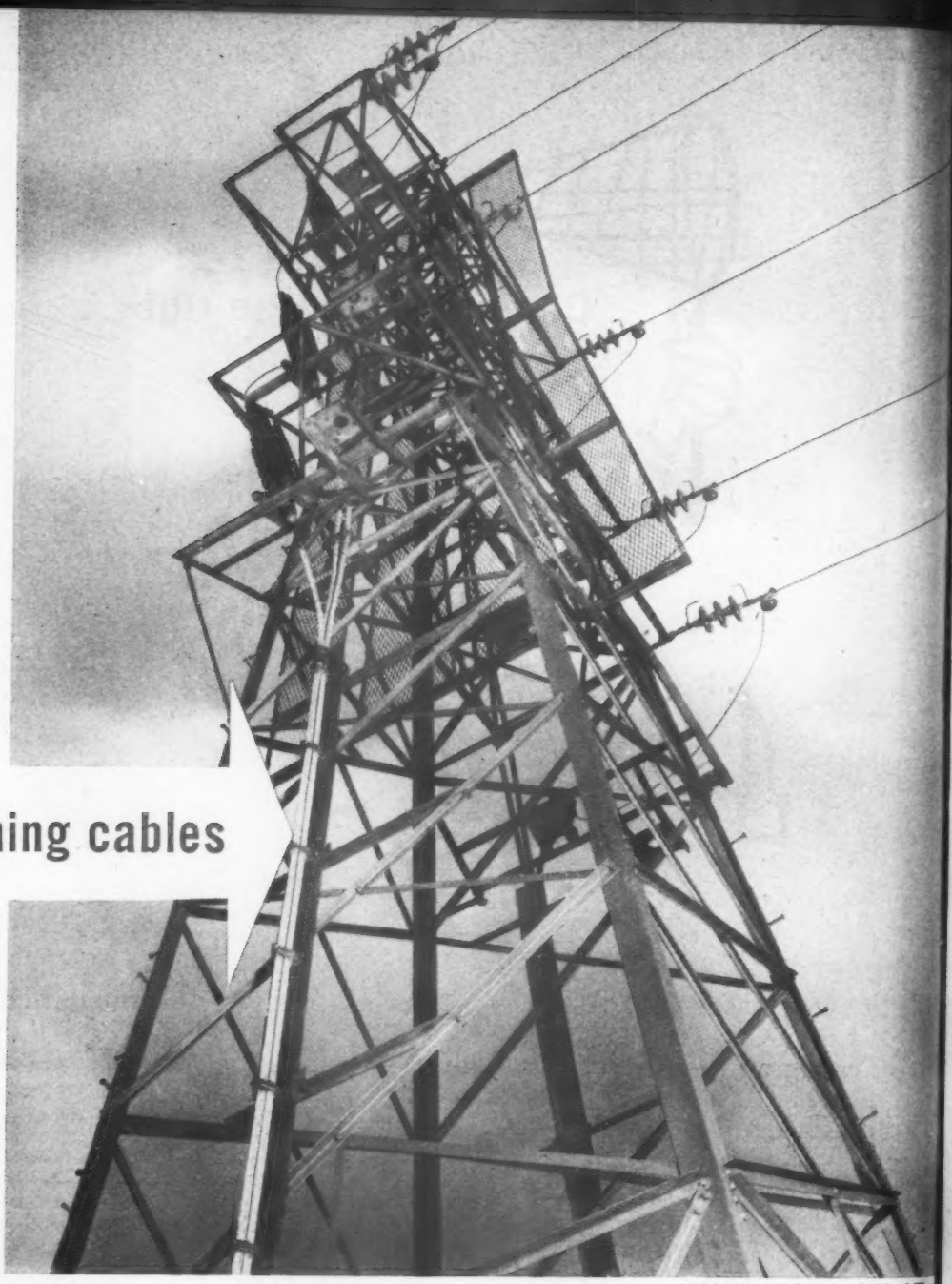

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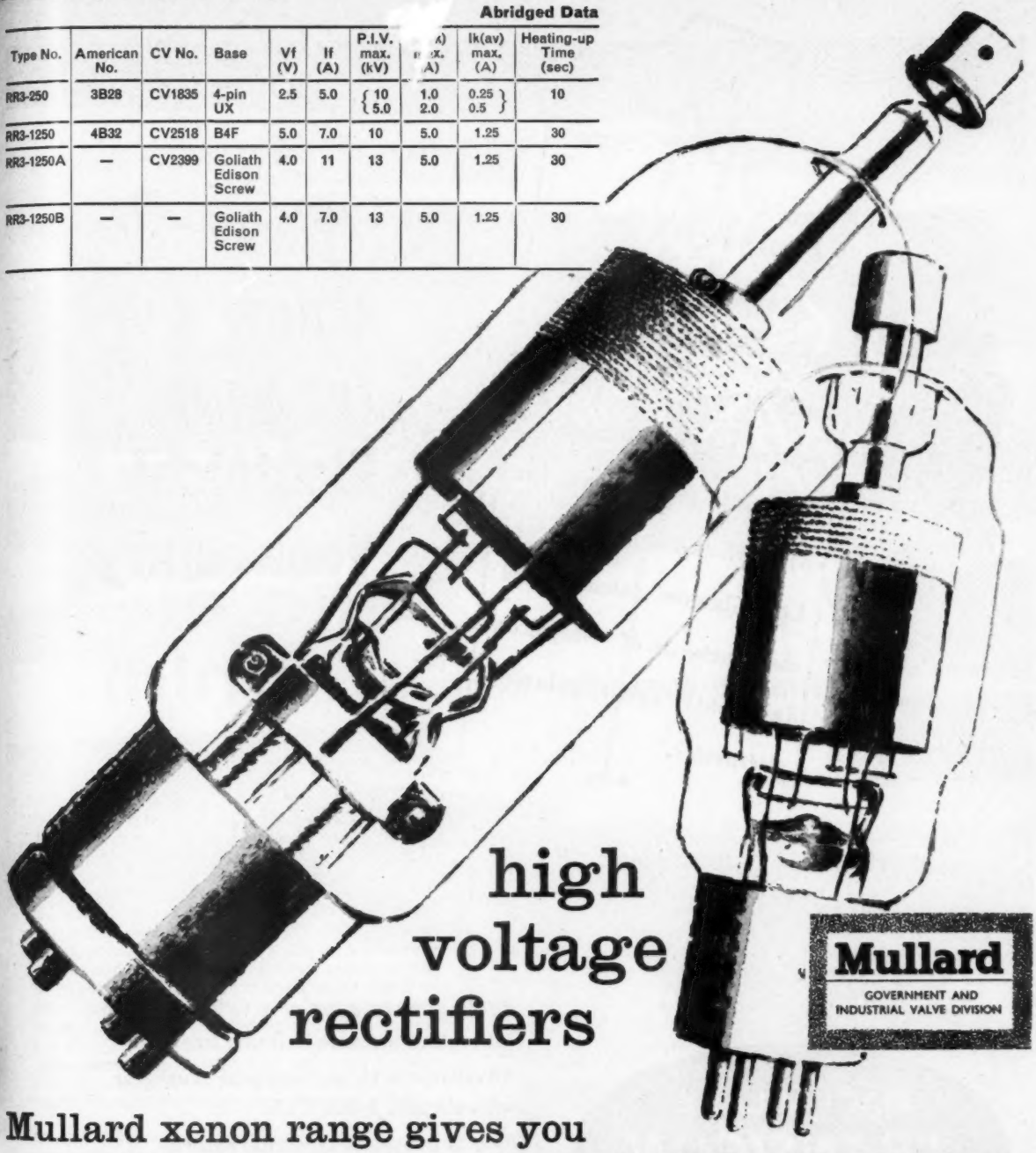
RR3-250	3B28	CV1835	4-pin UX	2.5	5.0	{ 10 { 5.0	1.0 2.0	0.25 0.5	10
RR3-1250	4B32	CV2518	B4F	5.0	7.0	10	5.0	1.25	30
RR3-1250A	—	CV2399	Goliath Edison Screw	4.0	11	13	5.0	1.25	30
RR3-1250B	—	—	Goliath Edison Screw	4.0	7.0	13	5.0	1.25	30



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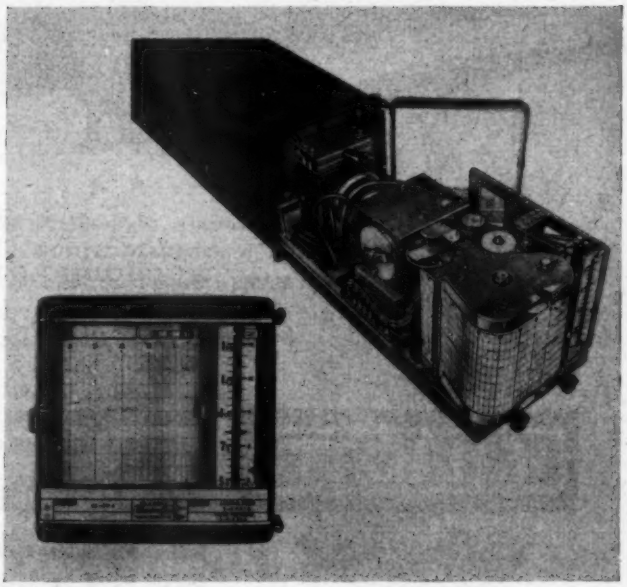

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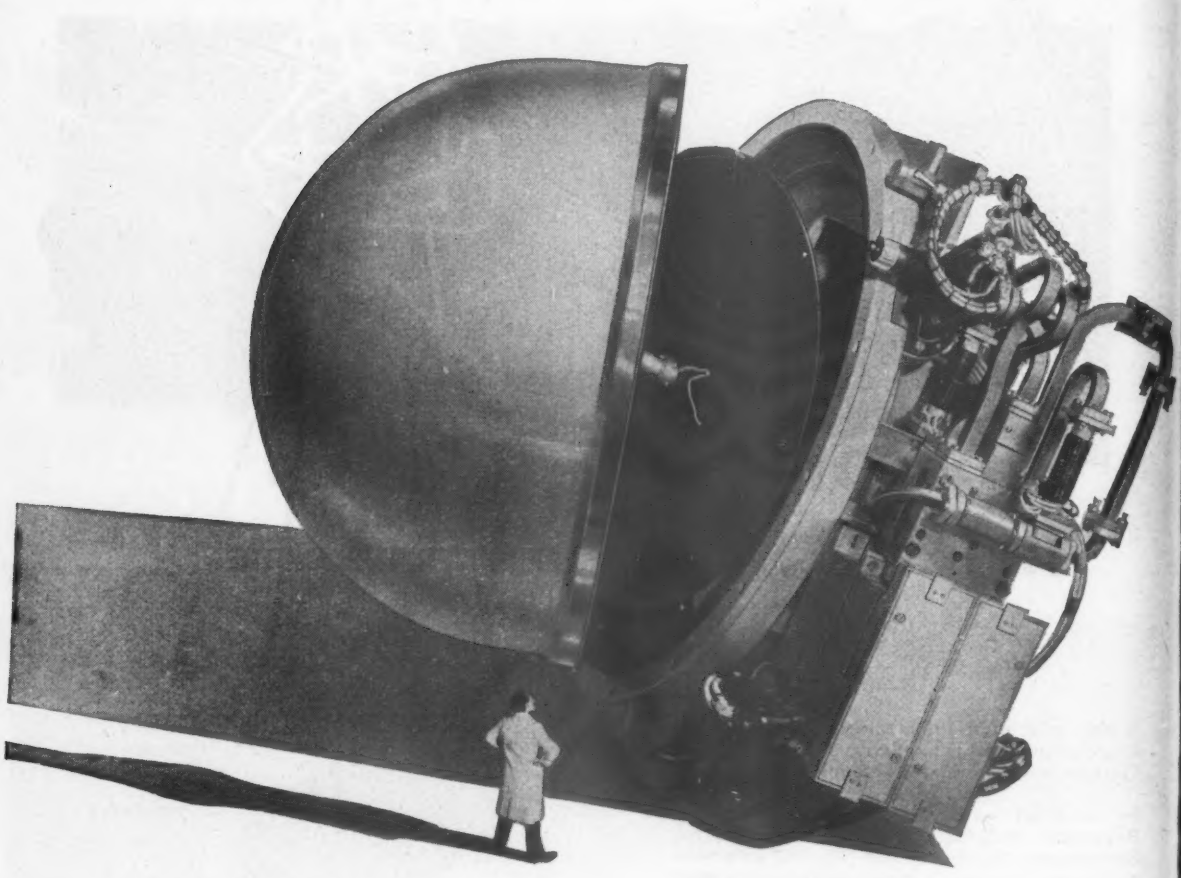

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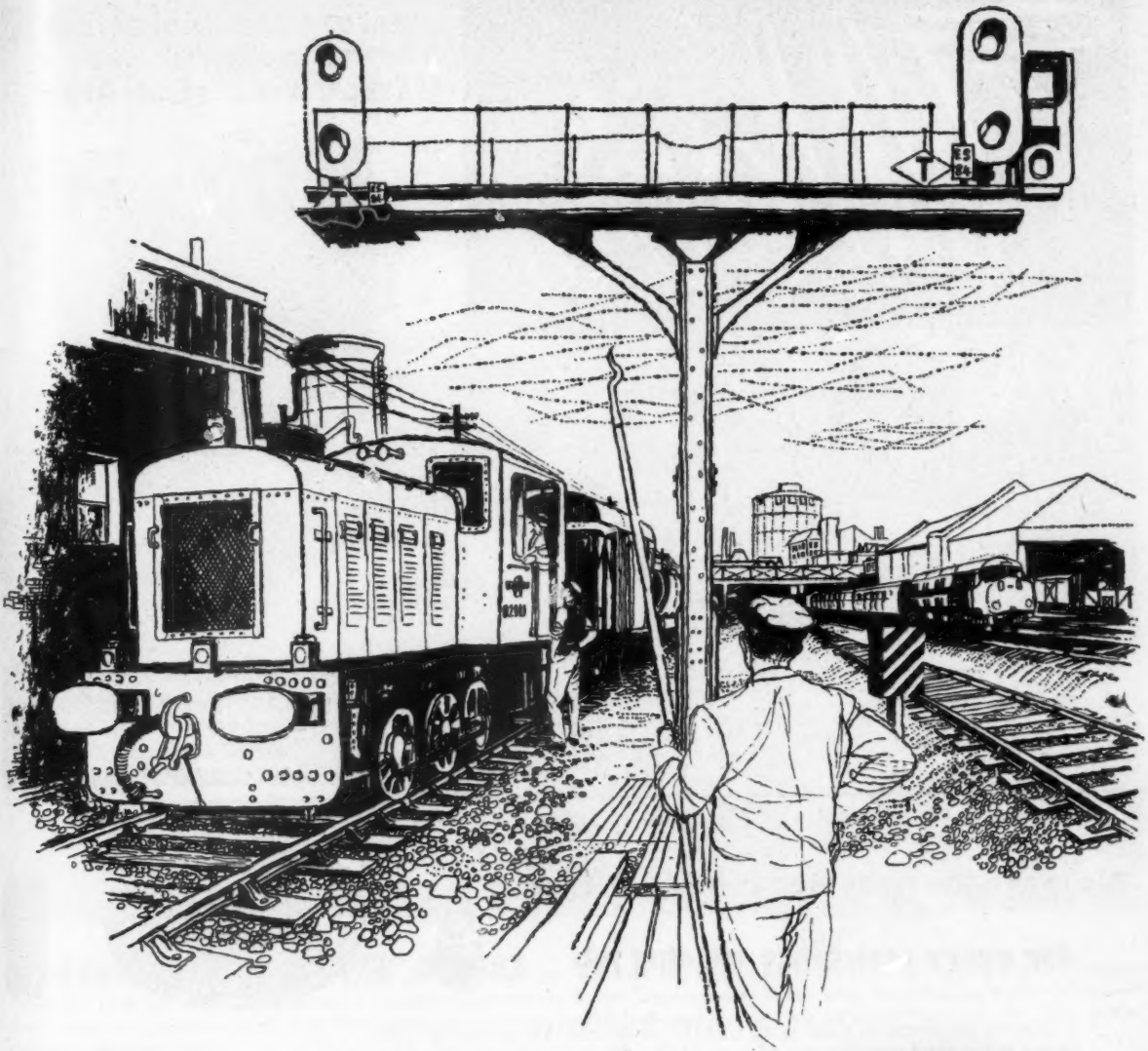

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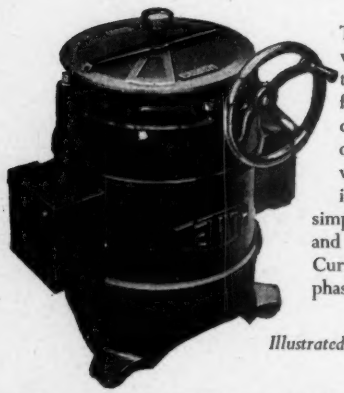

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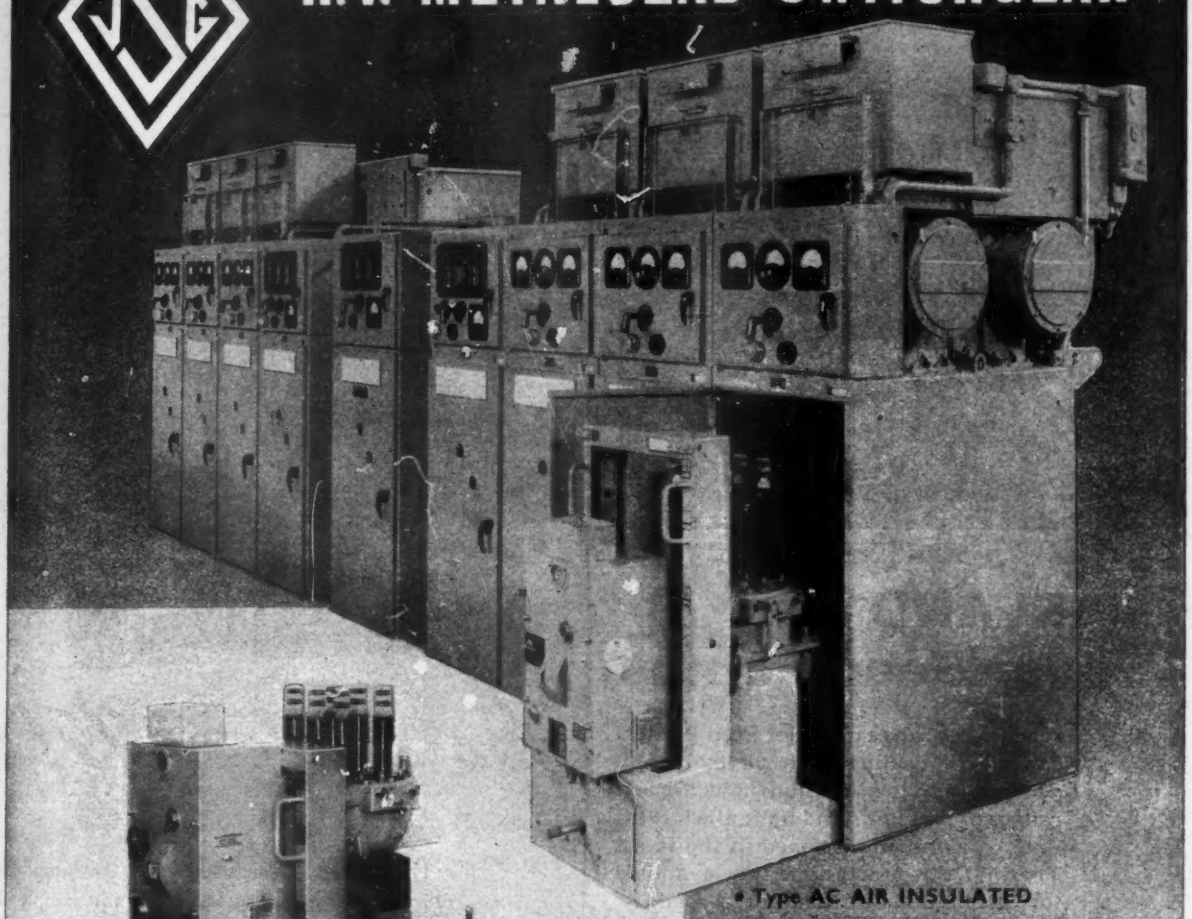

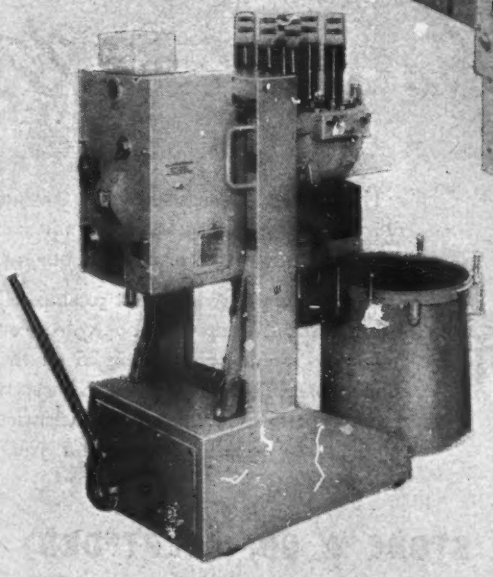

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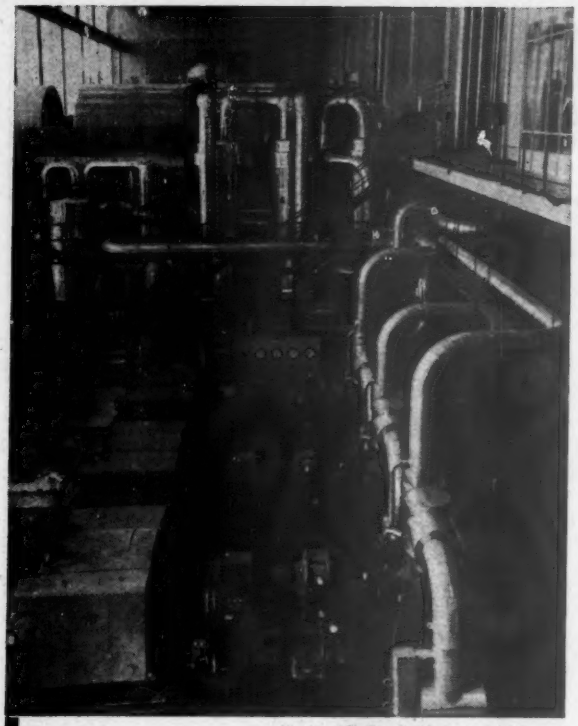

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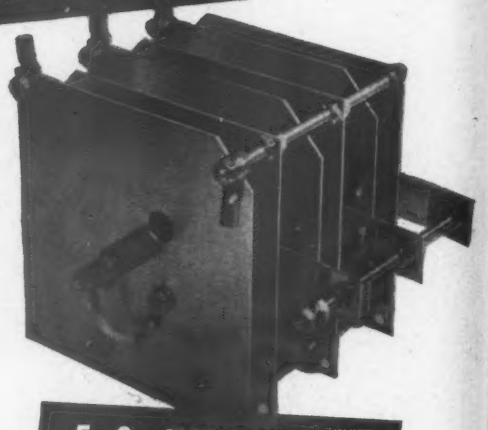

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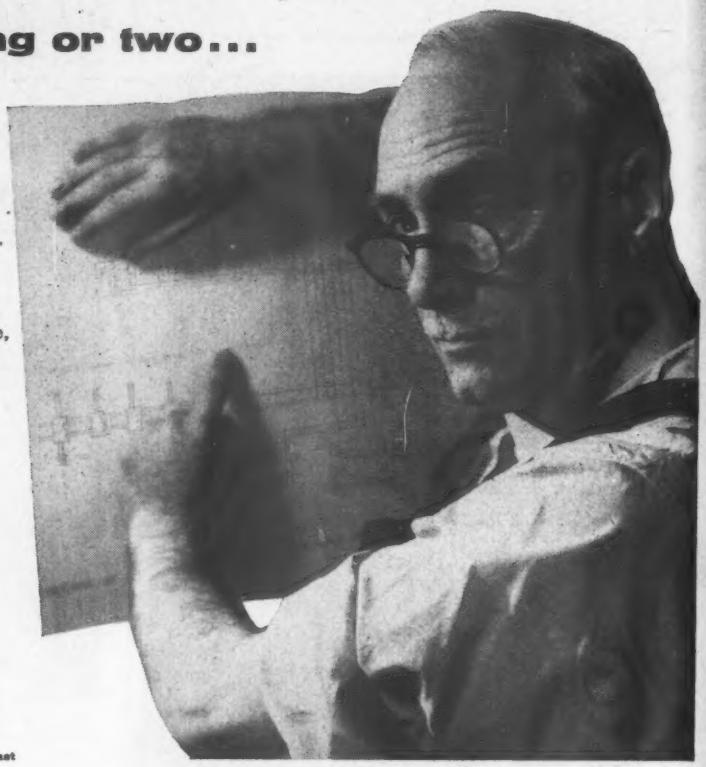

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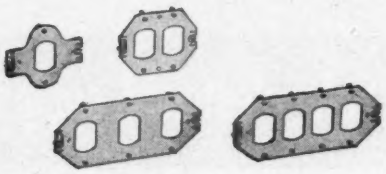
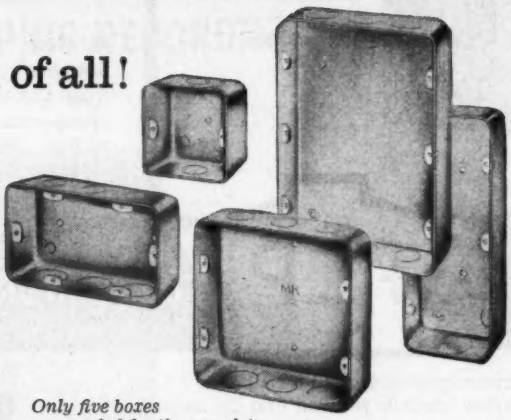
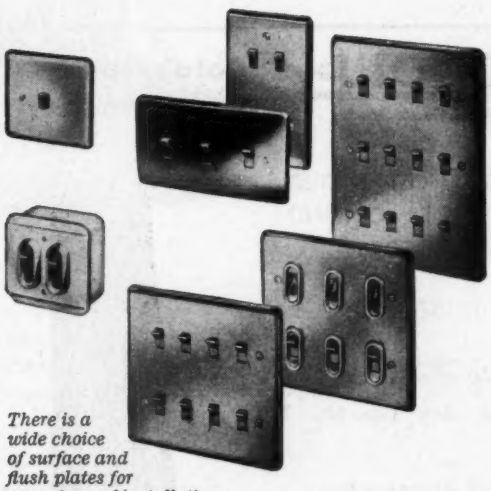


Switches up to twelve gang patterns can be assembled using only four grids.



Only five boxes are needed for the complete range of switches, whether mounted horizontally or vertically, on the surface or flush.

The extensive range of interchangeable components includes 5 amp one way, two way and intermediate switches, 15 amp one way, two way and DP switches, secret key switches, bell-pushes and neon indicators.



There is a wide choice of surface and flush plates for every type of installation.

The Gridswitch is the answer to uniformity of appearance throughout the largest scheme. Standard components result in quicker installation and lower costs. Every switch matches: every part is interchangeable. Extensions and alterations are easier: maintenance is simple beyond words. The MK Gridswitch has made all this a reality in very many of the latest buildings.

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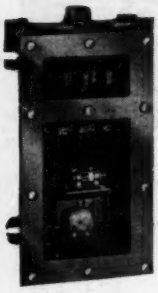
Single relays, each up to triple pole, are available in Buxton certified flameproof form. Mercury switch relay units of 1 to 6 stages can be supplied, covered by Certificate I.S. 3007 for the Hydrogen and Pentane classes; Certificate I.S. 1100 applies to single stage units for Methane.



Pressure Switches
Most types of Pressure Switch in our list 119/G can be supplied in Buxton certified flameproof form.

Air Flow Switches
Type AFS/FP, a switch to operate contacts on failure of air flow is Buxton certified for Groups I, II and III.

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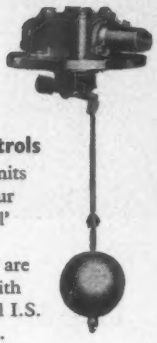

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Type	Strip Deflection Constant	Electrical resistivity Microhms-CMS at 20°C	Range of Max. Sensitivity °C	Useful Deflection Range °C	Stabilising Heat Treatment Temp. °C for one hour
140	14.0 x 10-6	76	20—230	–70—350	350
400	12.0 x 10-6	70	70—320	–70—400	350
15	9.5 x 10-6	16.7	20—160	–70—220	350
75	6.8 x 10-6	57	150—460	–70—550	350
38	3.8 x 10-6	56	150—460	–70—550	350
188	9.0 x 10-6	93	10—150	–70—550	350
131	13.3 x 10-6	18	10—150	–75—150	175
11	8.4 x 10-6	20	10—150	–70—350	350

**The deflection constant (d) is defined as the deflection of a strip of unit length and unit thickness for each °C rise in the temperature over the linear part of the deflection curve.*
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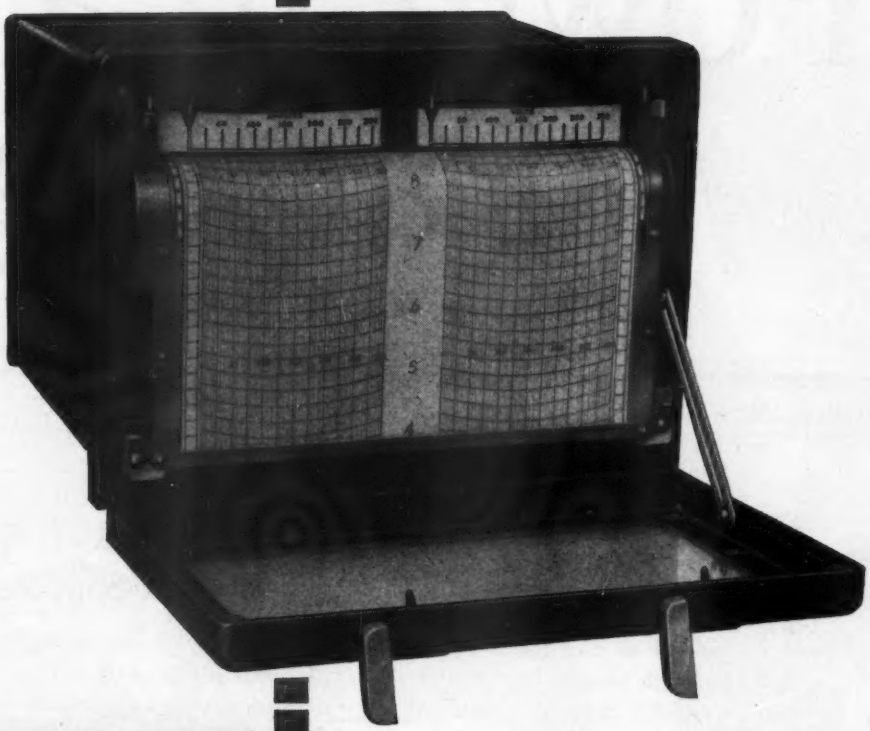

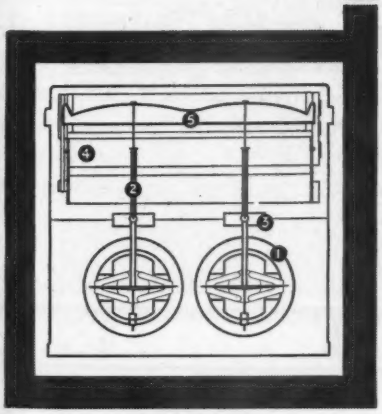

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Mitchell's new 'packaged' boiler supplies 10 tons of high-pressure steam an hour for Shell oilwells in Venezuela

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Mitchells are active in the fields of boiler design, cableways and ropeways, wagon handling, transporters and conveyors, cranes, mills, ship loading plant and nuclear power

Mitchell Engineering Limited

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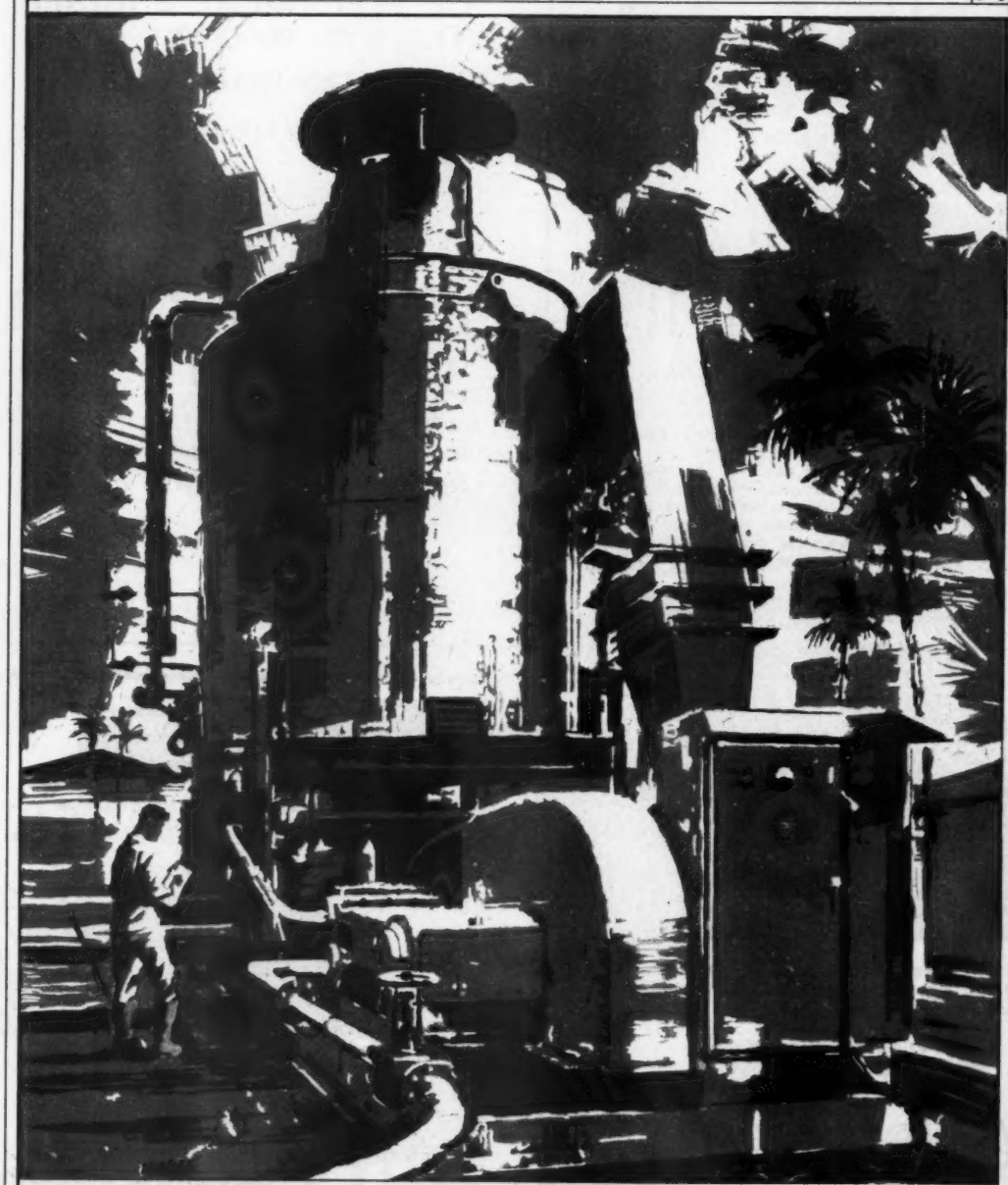
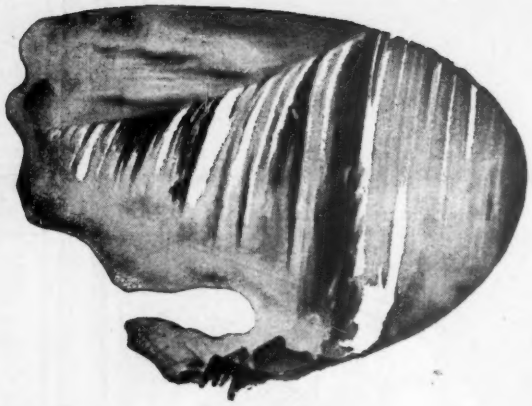
Mitchells 'packaged' coil boiler under test



MITCHELL



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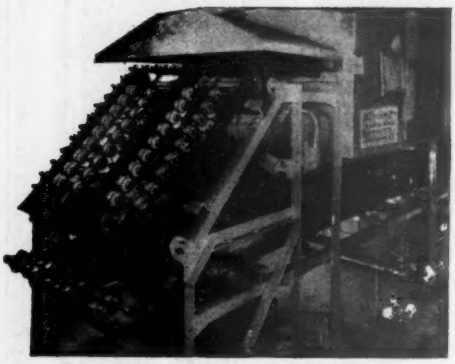

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TEN-YEAR INDEX

1942—1951

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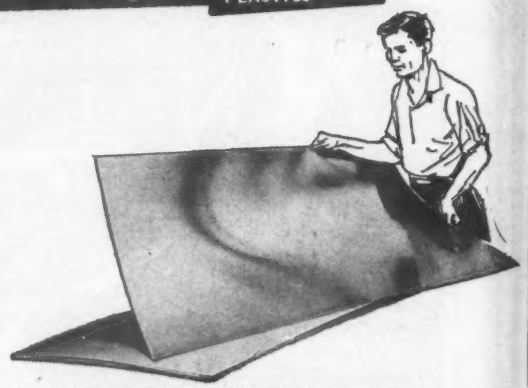

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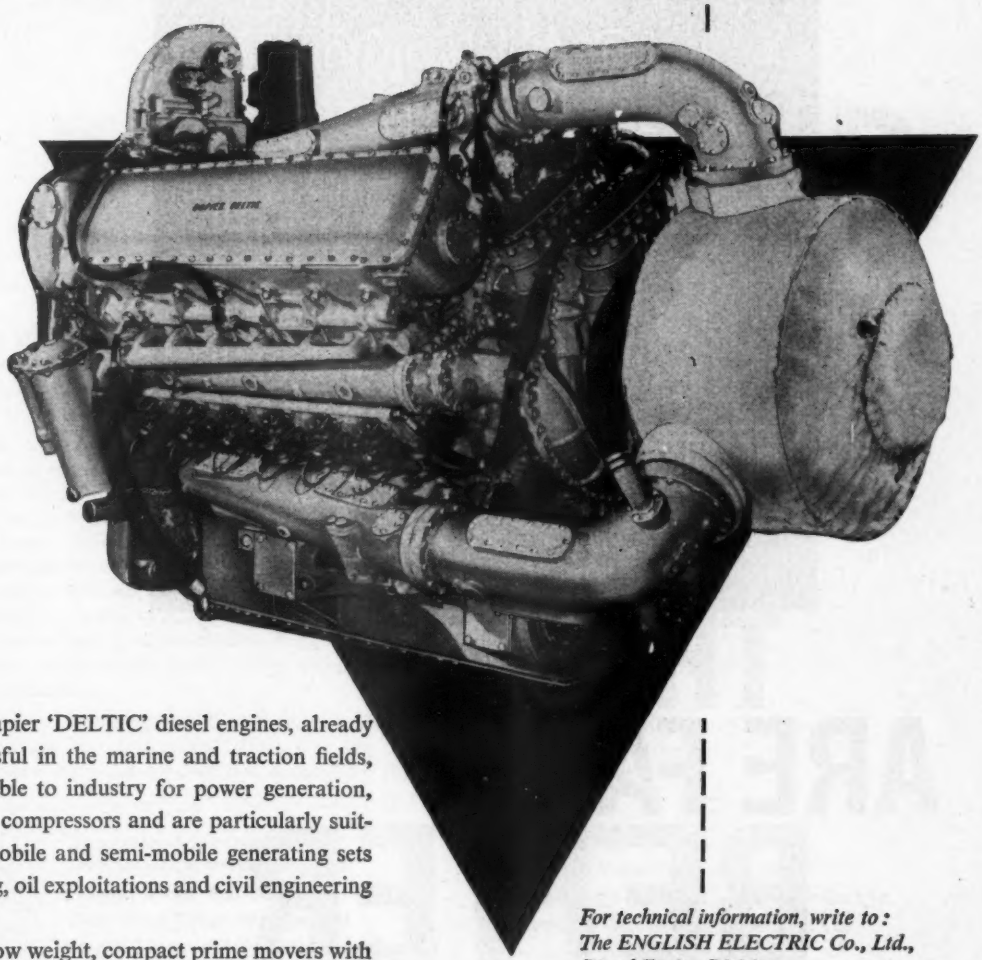

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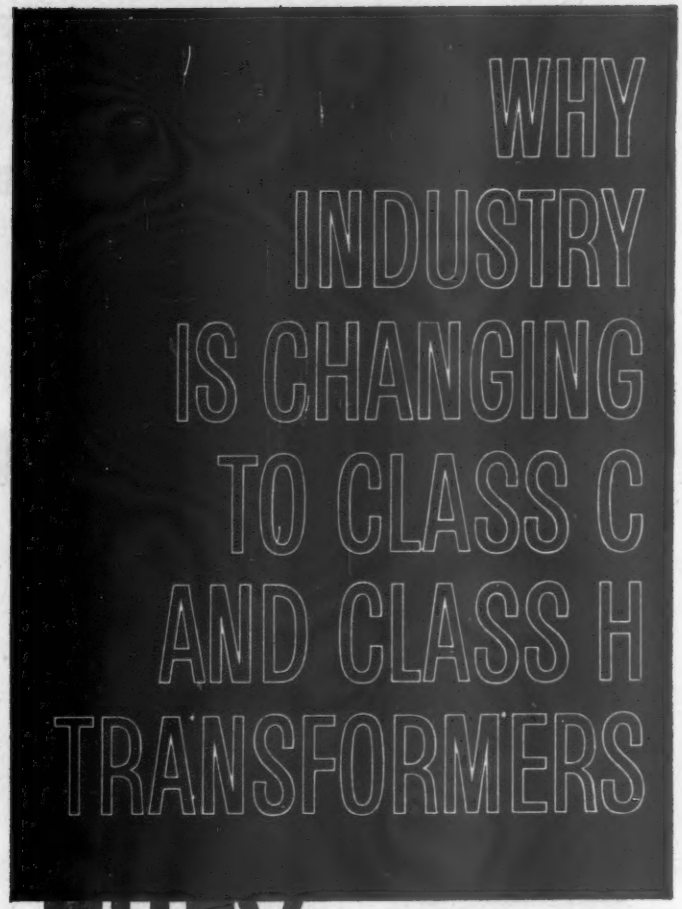

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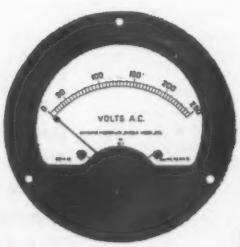

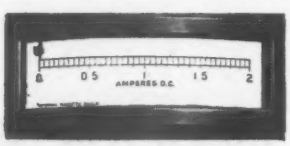

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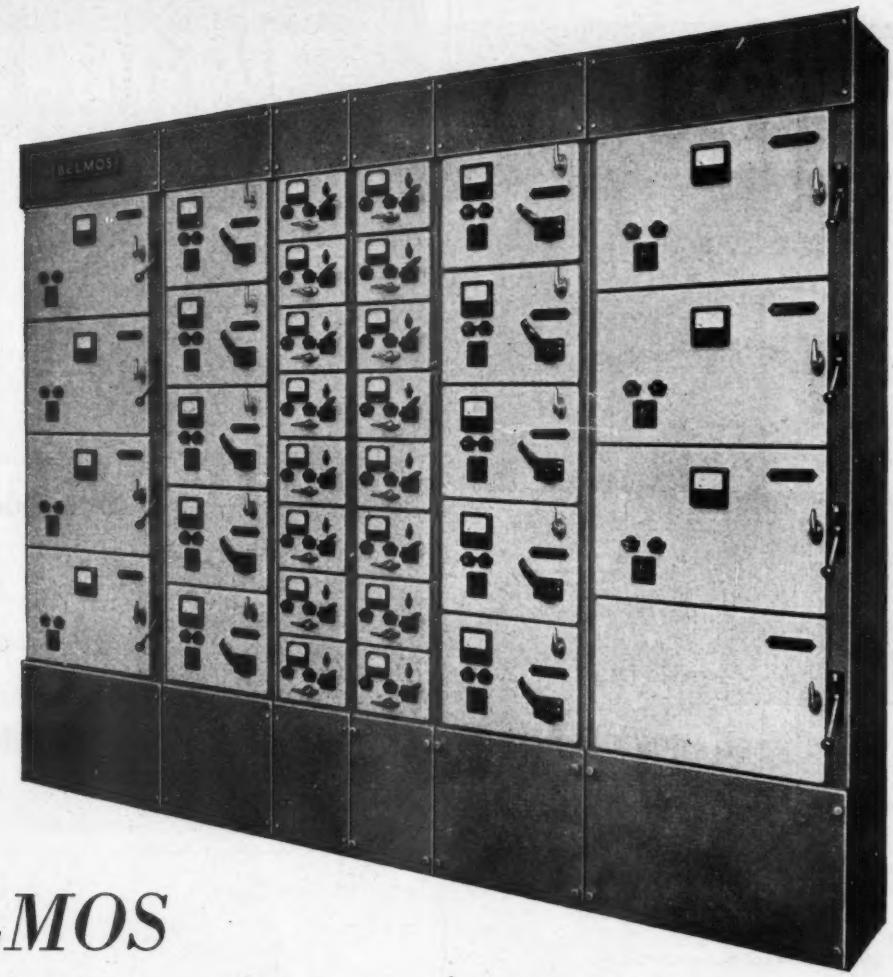

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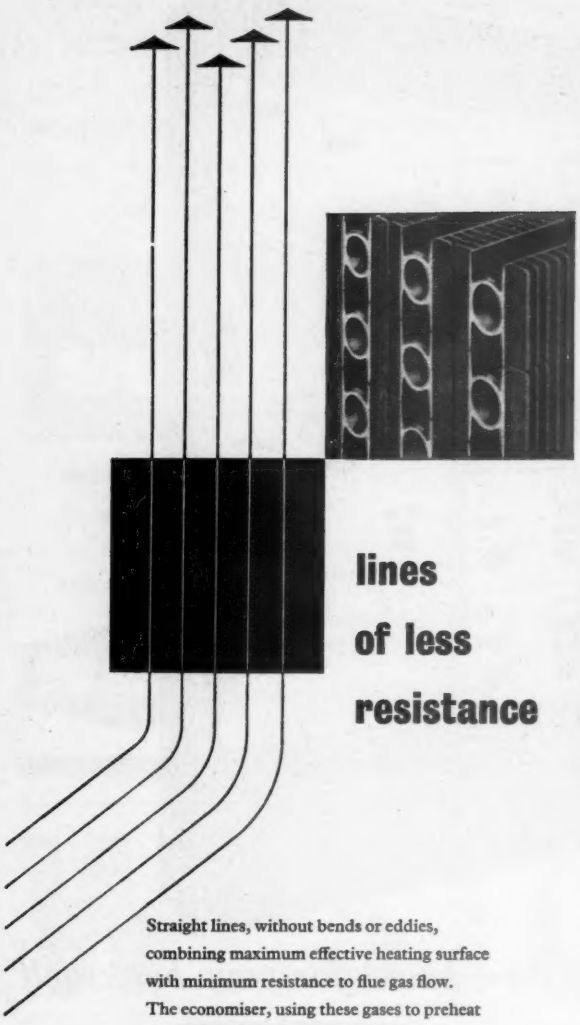

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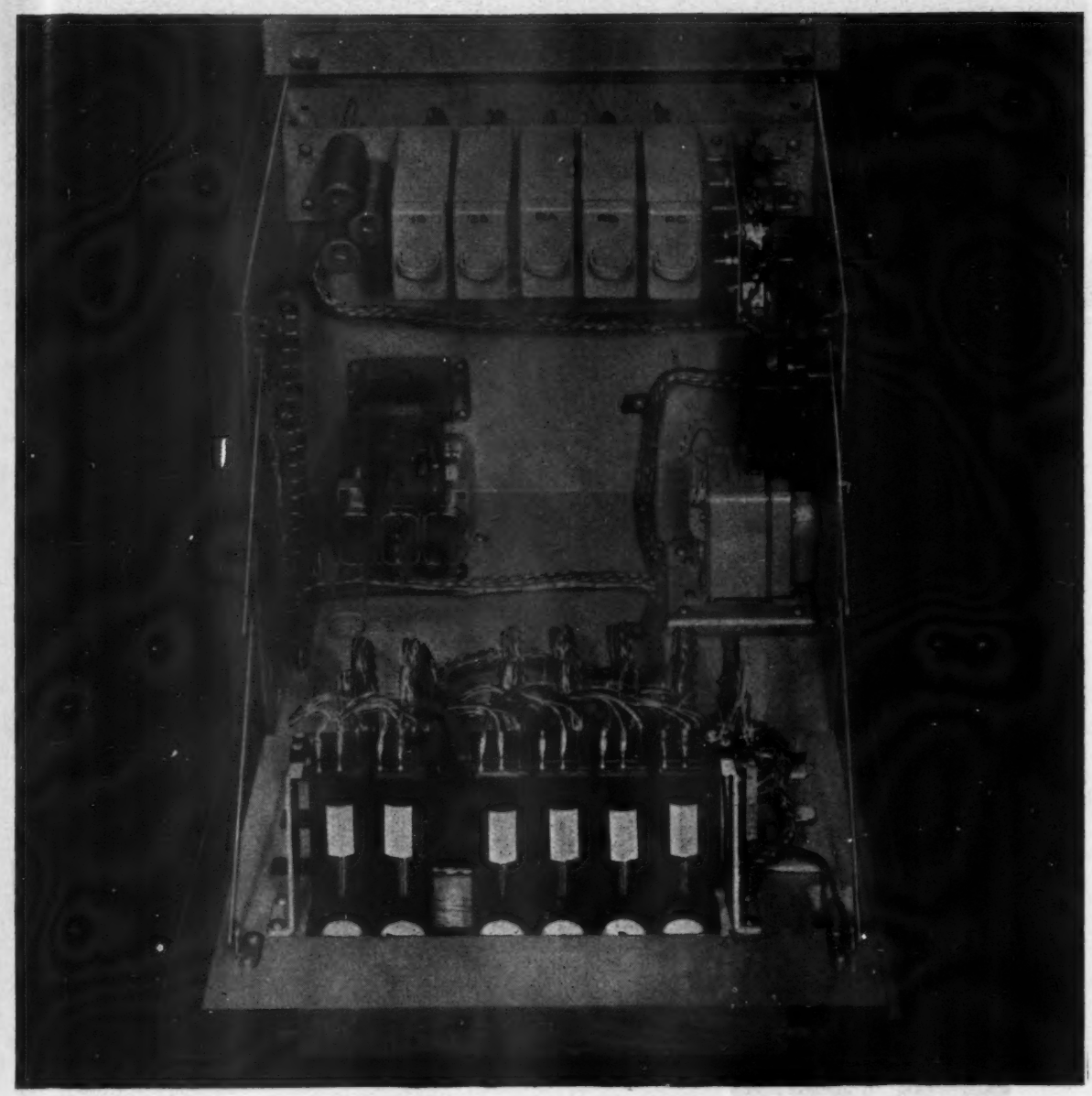

Corvic' covered wires made by Duratube and Wire Ltd. were used in this cordless P.B.X. switchboard made by Telephone Manufacturing Co. Ltd.

When wires for switchboards are to be covered with p.v.c.

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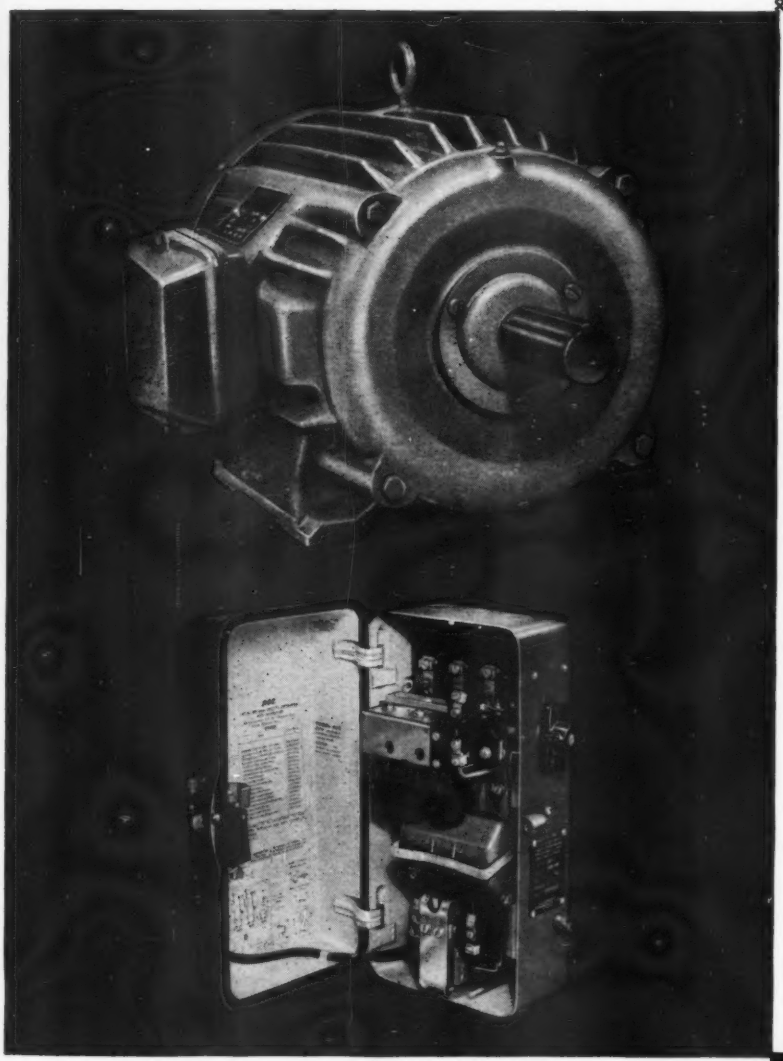

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